BRITISH COLUMBIA SEABIRD COLONY INVENTORY: REPORT #2: WEST COAST MORESBY ISLAND

Michael S. Rodway
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ABSTRACT

The Canadian Wildlife Service conducted detailed inventories of seabird colonies along the west coast of Moresby Island in 1985 and 1986 as part of the British Columbia Seabird Colony Inventory Program. All colonies in Englefield Bay and off the south end of Moresby Island were surveyed. A few small colonies along the stretch of precipitous coastline between those two areas were not visited. Total or partial counts were made for surface-nesting species and small colonies of burrow nesters. Burrow densities on larger storm-petrel and alcid colonies were estimated using systematic sampling within quadrats surveyed along line transects. Due to time constraints, burrow occupancy rates were not obtained at most colonies, and population estimates were based on median occupancy rates at other colonies in the province.

Almost half a million seabirds of 12 species are estimated to nest at 32 sites along the west coast and south end of Moresby Island. It is the only area in the Queen Charlotte Islands where Common Murres (Uria aalge) are known to nest and contains the only site in British Columbia where nesting by Horned Puffins (Fratercula corniculata) has been confirmed. The region supports 92% of the Rhinoceros Auklets (Cerorhinca monocerata) nesting in the Queen Charlotte Islands, as well as major portions of the storm-petrel (Oceanodroma spp.) (39%), Cassin's Auklet (Ptychoramphus aleuticus) (40%), and Tufted Puffin (Fratercula cirrhata) (60%) populations. Populations are concentrated in two clusters of colonies, one in Englefield Bay near the north end of Moresby Island, and one off the west and south sides of Kunghit Island at the south end of Moresby Island. The status of Marbled Murrelets (Brachyramphus marmoratus), which are assumed to breed in the region, is unknown.

Major concerns for breeding seabird populations include the spread and potential impact of introduced mammalian predators, and disturbance caused by increasing recreational traffic, especially within the South Moresby National Park Reserve.

RESUME

Dans le cadre du programe d'inventaire des colonies d'oiseaux marins de la Colombie Britanique, le Service canadien de la faune a effectué, en 1985 et 1986, des dénombrements détaillés des colonies d'oiseaux marins de la côte ouest de l'Île Moresby. Toutes les colonies de la baie Englefield, ainsi que celles au large de l'extrémité sud de l'Île Moresby ont été dénombrées. Les quelques petites colonies qui se trouvent le long des côtes escarpées de ces deux secteurs n'ont pas été dénombrées. On a fait des dénombrements partiels ou complets des espèces nichant en surface et des petites colonies d'espèces nichant dans des terriers. Pour évaluer le nombre de terriers dans les grosses colonies de pétrels tempête et d'alcidés, on a dénombré le nombre de terriers dans des quadrats localisés de façon systématique le long de lignes de transect. En raison du manque de temps, les taux d'occupation de la plupart des terriers n'ont pas été relevés; les évaluations des populations sont basées sur la moyenne des taux d'occupation d'autres colonies dans la province.

On estime qu'il y a près d'un demi-million d'oiseaux marins de 12 espèces qui nichent dans 32 endroits le long de la côte ouest et au sud de l'Île Moresby. On croit qu'il s'agit du seul secteur des Îles de la Reine-Charlotte où nichent les marmettes communes (Uria aalge); et par ailleurs, il s'agit du seul endroit confirmé en Colombie-Britannique où nichent les macareux cornus (Fratercula corniculata). Quatre-vingt-douze pourcent des pacareux rhinocéros (Cerorhinca monocerata) nichent dans les Îles de la Reine-Charlotte, de même qu'un pourcentage important de pétrels tempête (Oceanodroma) (39%), d'algues de Cassin (Ptychoramphus aleuticus) (40%), et de macareux huppés (Fratercula cirrhata) (60%). Les populations sont concentrées en deux groupes de colonies, l'un dans la baie Englefield, près de l'extrémité nord de l'Île Moresby, et l'autre, au large des côtes ouest et sud de l'Île Kunghit, du côté sud de l'Île Moresby. On présume que les algues marbrées (Brachyramphus marmoratus) se reproduisent dans la région, mais on ignore leur situation.

Parmi les principaux problèmes affectant les oiseaux marins nicheurs nous comptons l'invasion des mammifères prédateurs et les conséquences qu'ils peuvent entraîner, de même que la perturbation causées par l'augmentation du nombre de touristes, en particuleur dans le Parc national de Moresby-Sud.

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M. Rodway and M. Lemon conducted the surveys with the help of the following people. We enjoyed their company, and appreciated their stamina during surveys of often challenging and demanding topography. Most of the crew in 1986 were volunteers.
1985: D. Garnier and D. Power.
1986: A. Eisenhauer, D. Garnier, D. Grinnell, H. Hay, N. Holmes, G. Kaiser, D. Powell.

INTRODUCTION

All of the 12 species of seabirds known to nest in the Queen Charlotte Islands nest on the islands off the west and south coast of Moresby Island. The region, including all colonies from Skidegate Channel to the Kerouard Islands, currently supports almost half a million seabirds, nesting at 32 sites (Fig. WM-1, Table WM-1). It is the only area in the Queen Charlotte Islands where Common Murres (Uria aalge) are known to nest (Campbell and Garrioch 1979), and contains the only site in British Columbia where nesting by Horned Puffins (Fratercula corniculata) has been confirmed (Campbell et al. 1979). The region supports 92% of the Rhinoceros Auklets (Cerorhinca monocerata) nesting in the Queen Charlotte Islands, as well as major portions of the storm-petrel (Oceanodroma spp.) (39%), Cassin's Auklet (Ptychoramphus aleuticus) (40%), and Tufted Puffin (Fratercula cirrhata) (60%) populations (Rodway in press). These seabird populations are concentrated in two clusters of colonies, one in Englefield Bay near the north end of Moresby Island, and one off the west and south sides of Kunghit Island at the south end of Moresby Island. Between those two areas is a stretch of precipitous coastline with only a few small islands scattered along the outer coast and within the inlets.

Surveys by Summers (1974) in 1971 and by the B.C. Provincial Museum (now Royal B.C. Museum) in 1977 (Campbell and Garrioch 1979; BCNRS) identified most colony locations in the region, made total counts of surface nesting species, and made cursory population estimates of burrow nesting species. Except for surface nesting species (see Rodway 1988), those estimates could not be used to determine changes or monitor trends. During 1985 and 1986, the Canadian Wildlife Service completed detailed inventories in the two main clusters of colonies, in Englefield Bay and off the south end of Moresby Island. We did not resurvey the few colonies along the Moresby Island coast between those two areas. Data for surface nesting species has been extracted from Rodway (1988) and included here to present complete accounts of colonies in the region.

Breeding distribution and populations of Marbled Murrelets (Brachyramphus marmoratus), which likely nest in this region, are unknown. Special survey methodology will be required to address the unique conservation problems presented by this species (Sealy and Carter 1984; Rodway 1990).

The region has a variety of conservation and management problems which affect colonial seabirds. The southern cluster of colonies off Kunghit Island have recently been included in the South Moresby National Park. That area, especially around Anthony Island, is receiving an increasing tourist traffic which already may be having an impact on nesting seabirds (see Anthony Island account). Seasonal restrictions on access to colony areas, and other forms of protection will be required to conserve sensitive species and sites. Rats have been present on St. James Island for a number of years. We suspect they have been responsible for the elimination of Cassin's Auklets from the island, and may have affected the size and distribution of the Tufted Puffin population. We found a major colony in Englefield Bay (Saunders Island) abandoned by two nesting species, possibly as a result of the invasion by a mammalian predator. Nearby Instructor Island also showed signs of a declining population. Both islands are very close to the shore of Moresby Island and could easily be reached by swimming predators. We observed raccoons (Procyon lotor) in Boomchain Bay and had reports of them on Saunders Island. The spread of introduced raccoons is a concern throughout the Queen Charlotte Islands

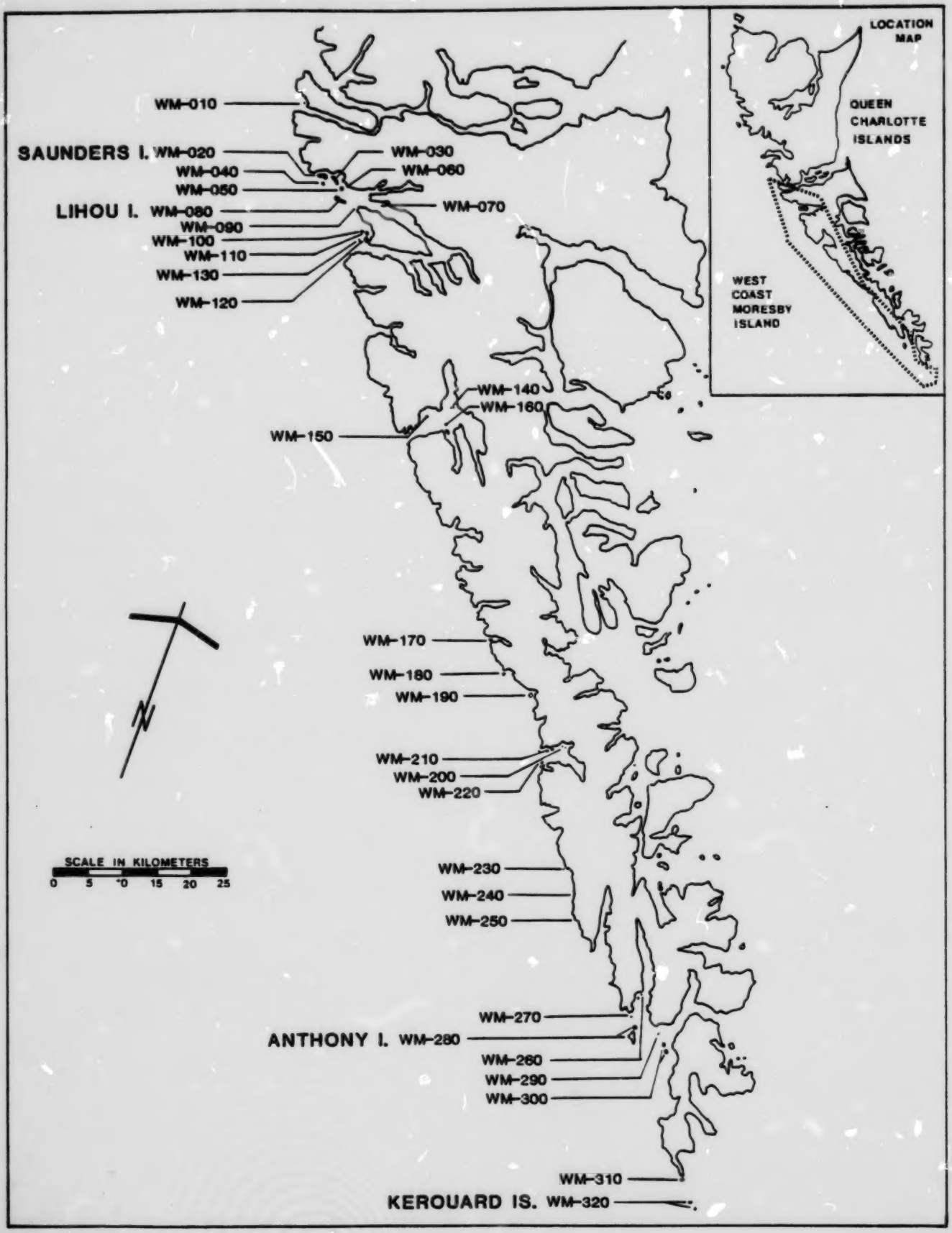


Figure WM-1. Seabird colonies on the west coast of Moresby Island.

(Summers and Rodway 1988). Further investigations are needed in the Englefield Bay area to determine the cause of seabird declines.

METHODS

Census methods were selected according to the area, habitat, and species of birds nesting on an island (Nettleship 1976). All islands were first explored to determine if nesting occurred. Small islands were completely examined. On large islands the entire perimeter was explored to a distance of 50 m from shore, plus frequent sections of the interior up to 200 m from shore. If no nesting seabirds were found no further searching was undertaken. If nesting was encountered exploration was continued to determine colony boundaries and the appropriate census technique.

1. Total Count. Total nest counts were made for Pelagic Cormorants (Phalacrocorax pelagicus), Black Oystercatchers (Haematopus bachmani) and Glaucous-winged Gulls (Larus glaucescens), unless nests were inaccessible. Population estimates equal the number of nests counted. For burrowing species, total counts were made when all burrows were accessible and easily tallied during the exploration of the island. This method was appropriate on small islands with few burrows, or on larger islands with scattered burrows around perimeter areas. Population estimates equal the number of burrows counted multiplied by the median occupancy rate (Appendix 1), rounded to the nearest ten. Nesting populations are estimated differently for surface and burrow nesting species because surface nests are constructed each year and represent a current reproductive effort, whereas burrows can persist for a number of years even when not being used (see Appendix III). Within the text, lists of nests counted use these abbreviations: Emp - empty; E - egg; Y - young; Ad - adult.

Total numbers of Pigeon Guillemots (Cepphus columba) sighted around colonies were counted, but no standardized observation techniques were employed (see Nettleship 1976), and no attempt was made to estimate actual nesting populations.

2. Partial Count. On small islands where a total count was not feasible or practical, but the colony area or population was too small to warrant sampling by transects, burrows in representative portions of the inland were counted and figures were extrapolated for the rest of the area. Population estimates equal the number of burrows estimated multiplied by the median occupancy rate (Appendix 1).

3. Strip Transects. These were used primarily on storm-petrel colonies that were too small to sample effectively with line transects. Measured strips of uniform width were run across the colony area, and all burrows were counted within them to give an estimate of the overall density of burrows. Occupancy rate, colony area, and total population were calculated as described below under line transects.

4. Line Transects With Quadrats.

Line transects were used on all large colonies of burrow-nesting species.

4.1. Transect location. After the colony was mapped during exploration, equally spaced transects were run throughout colony areas. In areas where the coastline was straight, transects were laid out upslope, generally

perpendicular to the shoreline. On smaller islands, or around points or bays of large islands, where the coastline was concave or convex, transects were laid out along parallel bearings to avoid convergence or divergence inland. Such transects were run across the long axis of an island or point, to insure representative sampling of variations in species distribution and burrow density. Transect spacing ranged from 75 m to 200 m apart, depending on the size of the colony and the size of the quadrats (see below). We attempted to sample 1% of the area of a colony. That value was the maximum sampling effort we found possible within a practical time frame. Transects were placed half a "spacing" distance from the borders of a colony, and unless the colony edge was at the island shore, a transect was run outside the edge to insure that our mapping was accurate, and to provide a sample of "non-colony" so that changes in colony extent could be reliably interpreted on future surveys. Transects were located either by measuring the spacing distance along a line perpendicular to the transect bearings (along the shore if this was feasible), or by locating reference points plotted on air photos (for areas where the topography was extremely dissected or impassable).

4.2. **Quadrats:** Quadrats were set at predetermined intervals along transect lines, with the first quadrat at the shore edge of the vegetation, unless that was inaccessible, and the last placed beyond the interior extent of the colony. Plots ranged in size from 3x3 m to 7x7 m, depending on the density of burrowing. The size was selected so that an average of at least one burrow occurred in each quadrat. Low density colonies of Ancient Murrelets (Synthliboramphus antiquus) often required large plots to obtain burrows within them, while dense colonies of storm-petrels or Cassin's Auklets could be sampled with smaller, more frequent plots (Savard and Smith 1985). Quadrat spacing varied from 15 m for 3x3 m plots, to 40 m for 7x7 m plots.

Burrows were counted within each quadrat to determine burrow density. Burrow characteristics were recorded: location (ie, under roots, stumps, logs, grass tussocks, etc.), accessibility (whether it was obscured, or obstructed), and signs of activity (droppings, feathers, etc.), both at the entrance and in the tunnel. If within one arm's length, entrances connected into the same tunnel, only one burrow was recorded and the number of entrances was noted. Habitat parameters were measured: distance from shore, altitude, slope, percent and species composition of ground cover, shrub cover, and forest canopy. To place the quadrat in the context of the overall habitat, tree species, percent composition, and average size (dbh), and general terrain features were documented for the area surrounding each quadrat within a radius equal to half the distance between quadrats. Evidence of predation (eggshells, carcasses, feather piles) within each quadrat was recorded, and the overall density of predation evidence was calculated in the same fashion as burrow density.

4.3. **Colony area:** Colony area was defined to include all portions of an island where burrows with recent signs of activity (droppings, feathers, regurgitated food, fragments of eggshell or egg membrane, worn entrances or tunnels, excavation, or fresh nesting material) were located. If burrows were located, but no signs of recent activity were observed in an area, the colony was considered abandoned. If there were no burrows within a quadrat, the surrounding area was searched for colony evidence to determine if the plot fell within the colony and should be used in density calculations. If no burrows were found within a distance halfway to adjacent quadrats along the transect, nor within a lateral radius half the distance to adjacent transects, then that area was excluded from the colony and the plot data was not used in density calculations. If burrows and signs of activity did occur within this

range, then the area was considered colony and the plot data was used as part of the burrow density sample. If active looking burrows were observed in the vicinity of one quadrat, but were absent from the area surrounding an adjacent quadrat, the colony boundary was delimitated half way between the two quadrats, unless an obvious border was encountered. The same criteria was applied between transects. This degree of resolution of colony boundaries was as accurate as time and equipment allowed for extensive Ancient Murrelet colonies. For storm-petrels, Cassin's Auklets and Rhinoceros Auklets, whose colony boundaries were usually less extensive and more discrete, a finer resolution could be obtained, and precise measurements were often possible.

Distance, elevation, and slope measurements taken along the transects, as well as during the exploration, were used to draw colony areas on detailed topographic maps or air photos. The horizontal surface area of the colony was measured on that map with a compensating polar planimeter. Adjusting for slope, the area of the colony was given by:

$$C_s = A_h \, T^2 \, (\cos \bar{x})^{-1}$$

where C_s is the colony surface area, A_h is the area on the map, T is the scale of the map, and $\bar{x}$ is the mean slope along the transects. Our colony area calculations take into account the average uphill slope, but not the undulations between quadrats or between transects. Therefore our calculations give a conservative estimate of the total surface area available to the birds for nesting.

4.4. **Burrow density:** Data from all the plots within colony area were used to calculate an average burrow density for the entire colony. This overall density was used for population calculations. If marked and consistent differences in densities were encountered in different parts of a colony, those areas were separately mapped and individual density rates were calculated. Assigned density classes (high and low) are unique to a particular colony and cannot be equated to those designated for other colonies. Their purpose is to demarcate areas of nesting concentration within a colony. Densities are quoted plus or minus one standard error. On figures, burrows/ha is abbreviated to b/ha.

4.5. **Occupancy:** The percentage of burrows that actually contained nesting birds was determined by complete examination of a sample of burrows. If an adult, an egg, a chick, or freshly hatched egg membrane was found, the burrow was considered occupied. Burrows were considered empty if all tunnel branches were explored and none of the above were found. Signs such as a well worn entrance or droppings were not used to distinguish between occupied and empty burrows. Exploring burrows longer than an arm's reach required digging one or more access holes until the end was reached. Dug holes were immediately patched over. The contents of many burrows were impossible to determine because they extended under roots or fallen trees or into cavities within tree bases. To minimize disturbance, adults were not pulled from burrows except to confirm species identification.

To obtain a representative sample of the entire colony, we attempted to determine the occupancy of each burrow located within surveyed quadrats. Due to time constraints we were often unable to explore burrows in every quadrat. In those cases we selected quadrats from as many areas of the colony as time permitted and explored every burrow in each quadrat selected. On some colonies, transects were run early in the nesting season before all birds were nesting, and occupancy was determined later in one or two areas. Areas were chosen where burrows were frequent and a sample could be obtained within a reasonable time frame. To minimize the bias within those areas, we started from a central point and explored every burrow encountered within an expanding radius until we had an adequate sample. The size of those areas was not measured. Their locations are indicated on colony maps.

When we had data on occupancy from several plots, we calculated the occupancy rate according to the formula:

$$R = \frac{\bar{x}}{\bar{y}}$$

where x is the number of occupied burrows in each quadrat and y is the total number of burrows of known status in each quadrat.

The variance of R is calculated from:

$$Var(R) = \frac{\bar{x}^2}{\bar{y}^2}\left[\frac{s_x^2}{\bar{x}^2} + \frac{s_y^2}{\bar{y}^2} - \frac{2s_{xy}^2}{\bar{x}\,\bar{y}}\right]$$

where s_x is the standard error of $\bar{x}$, s_y is the standard error of $\bar{y}$, and s_{xy}^2 is the covariance of $\bar{x}$ and $\bar{y}$.

The standard error of R is then the square root of Var(R).

On some colonies an occupancy rate was not determined either due to lack of time or because our survey occurred too early or too late in the breeding season. To estimate a nesting population on those colonies we used a median occupancy rate based on data from all other colonies of that species surveyed in British Columbia (Appendix I). To calculate a median rate for storm-petrels we only used occupancy rates determined when both species were nesting (see Vermeer et al. 1988), unless there was only one species present. On some colonies we were too early to determine an occupancy rate for Leach's Storm-Petrels (Oceanodroma leucorhoa), but were able to obtain a rate for Fork-tailed Storm-Petrels (O. furcata). In those cases we calculated population estimates for both species by using the median storm-petrel occupancy rate, deriving the number of Leach's Storm-Petrels by default according to the formulas:

$$P_F = B\,\frac{F+E\,\frac{F}{F+L}}{K}$$

$$P_L = BM - P_F$$

where P_F and P_L are nesting population estimates for Fork-tailed and Leach's Storm-Petrels respectively, B is the total number of burrows in the colony, F and L are the numbers of known Fork-tailed and Leach's Storm-Petrel burrows at the time of the survey, E is the number of occupied but unidentified burrows (e.g. cold eggs), K is the total number of burrows with known contents, and M is the median occupancy rate. We assumed that occupied but unidentified burrows belonged to the two species in the same proportion as identified burrows. The actual proportion would likely vary at different times in the season.

4.6. **Total burrows and current nesting estimates:** The total number of burrows (B) is the product of the overall average density of burrows as determined in the quadrats and the total area of the colony. B multiplied by the occupancy rate, (R) gives an estimate of nesting pairs (P). Calculations are quoted plus or minus one standard error.

The variance of P is calculated from

$$Var(P) = B^2 Var(R) + R^2 Var(B) - Var(B) * Var(R)$$

The standard error of P is then the square root of Var(P).

Distinguishing species:

The burrows of different species are often mixed. This presents problems for the surveyor when burrow contents cannot be determined. Identification of burrows must then be based on indicative signs found in the burrow or at the burrow entrance. We developed a set of criteria for distinguishing burrows of storm-petrels, Ancient Murrelets, Cassin's Auklets and Rhinoceros Auklets: size of entrance; wear at the entrance; droppings in and around the burrow entrance; regurgitated food (for Cassin's Auklet); feathers found in the burrow; eggshell fragments found in the burrow; and odour. Few Tufted Puffins nest in association with any of these species in the Queen Charlotte Islands. There are a few mixed with Cassin's Auklets on the Kerouard Islands, but their burrows were readily distinguished by size.

Storm-petrels often nest in conjunction with Cassin's Auklets and less often with Ancient Murrelets. Little difficulty is usually encountered differentiating storm-petrel burrows according to size (5-7 cm in width). The musty odour of petrels is also helpful.

Ancient Murrelets, Cassin's Auklets and Rhinoceros Auklets are found nesting in the same areas, though the most frequent associations are Ancient Murrelets and Cassin's Auklets, or Cassin's Auklets and Rhinoceros Auklets. Ancient Murrelet and Cassin's Auklet burrows are similar in size (10-12 cm in width), while larger burrows (12-15 cm in width) generally belong to Rhinoceros Auklets. Droppings, regurgitated food, eggshell fragments, and feathers provide more conclusive evidence for differentiating these three species. Ancient Murrelets and Rhinoceros Auklets have relatively clean burrow entrances. Rhinoceros Auklet burrow entrances are more worn than Ancient Murrelet's. Ancient Murrelet droppings are yellowish-white and are usually placed away from the entrance. The droppings of Rhinoceros Auklets are larger, generally globular, pale yellow with black, viscous blobs, and are often deposited to one side of the burrow entrance. Cassin's Auklets leave white fecal streaking along the approach and into the entrances of their burrows.

Cassin's Auklet droppings also have a more arresting odour, as does their regurgitated food, some of which they invariably lose at the entrance to their burrows when they are delivering it. Abdominal feathers (which are often lost in the burrows) of each species can be distinguished by the colour pattern of their plumules (size is not reliable). Ancient Murrelet plumules are half dark and half white. Cassin's Auklet plumules are mostly dark with a tip of white. The colour of the Rhinoceros Auklet plumule is uniform greyish white and is similar to that of the base of the main feather. Eggshell fragments of Cassin's Auklets and Rhinoceros Auklets are both white and are inseparable unless a major portion of the shell is present and can be distinguished by size. Fragments of Ancient Murrelet eggshell are easily identified by their colour - pale olive background with dark speckling throughout.

Predation:

During exploration, notes were kept of all signs of predation or mortality encountered. Areas around Bald Eagle, Peregrine Falcon, and Common Raven nests, and around river otter runs and dens were examined in detail. This gave an indication of the degree and the kind of species being preyed upon. To estimate the level of predation, we calculated the density of prey remains recorded in the quadrats, using the minimum possible number of birds represented by the evidence found. We assumed that one feather pile represented one bird. This estimate can only be used as a coarse comparison from colony to colony because our surveys occurred at various times in the nesting season. It underestimates total predation because our plots only sample remains left within the colony before the end of the season.

Staging:

Near dusk, prior to flying into their nesting slopes, Ancient Murrelets and Rhinoceros Auklets typically flock up on the water adjacent to their colony. To locate these staging areas, water transects were run when the weather was calm enough to see birds on the water. Bearings, distance from shore, time, and number of birds sighted were recorded for each water transect. Locations of staging concentrations were determined by proximity and bearings to recognized points of land. If birds were not encountered, the boat was often stopped so that birds might be heard calling from the water. This was only useful for Ancient Murrelets, as we have never heard Rhinoceros Auklets calling on their staging areas.

Time:

Times quoted are Pacific Standard Time, adjusted to Daylight Savings Time at 0200 h on the last Sunday in April of each year (28 April 1985, 27 April 1986) unless otherwise noted. Subtract one hour from Daylight Savings Time to get Pacific Standard Time.

ISLAND ACCOUNTS

WM-020 SAUNDERS ISLAND 103 F/1

Location: At the northwest corner of Englefield Bay. 53°01'45"N 132°28'W

Land status: Provincial Crown Land.

Date of survey: 13 May, 1100-1700 h (exploration), 25 May, 1100-1800 h (transects), and 29 May 1986, 1500-1800 h (burrow longevity plot).

Colony access: Sheltered landing beach on the mid-north side.

Base camp: We camped on nearby Helgesen Island, but camping may be feasible on the mid-north side of Saunders Island, though much of the ground was wet and rose abruptly close to shore. We saw no sign of running water, but water was plentiful in nearby bays on Moresby Island.

Observers: M. Lemon, M. Rodway, D. Powell, A. Eisenhawer, D. Garnier, D. Grinnell, R. Hoar, K. Moore.

Census method: 48 quadrats (3x3 m) were surveyed at 15 m intervals along 13 line transects spaced 100 m apart and run perpendicular to shore (Fig. WM020-1, Table WM020-1). An experimental plot to monitor burrow longevity was established on the mid-south side of the island (see Appendix IV).

Description: Saunders is a steep-sided, 55 ha island, rising to a maximum elevation of 70 m along the western ridge. There are rock bluffs, cliffs and dissecting crevices around much of the perimeter, especially on the south side, often with flat tidal shelves at their bases. The rock shelf on the southeast corner is extensive. There is a substantial beach on the mid-north side, and pocket beaches occur at the upper reaches of some of the tidal shelves. Slopes above the shore rock are steep [ranging from 6 to 50° and averaging 28° (Table WM020-1)], gradually rounding to the crest of the east-west running backbone of the island. The crest tends to be closer to the north side of the island where the slopes are more abrupt.

On the south side, the steep slopes above the rock are grassy (primarily Calamagrostis nutkaensis) under mature, 0.7-1.0 m dbh Sitka Spruce (Picea sitchensis). The grass covers the noses of ridges between dissecting gorges, and extends 40 to 50 m up the interior slopes, where it gives way to moss and bare litter under a more predominantly Western Hemlock (Tsuga heterophylla) and Western Redcedar (Thuja plicata) forest (dbh = 0.5-0.6m). Extensive patches of spruce seedlings (1.0 m tall) occur in the interior, and mix with young hemlock (3-5 m tall) on higher ground towards the east end. Thickets of young spruce become more profuse on the north side of the island, especially on the eastern half where older deadfall and windfall are frequent. The soil is wet and thin on many of the steep northern slopes. Slopes or knolls between cliffs and crevices, which are free of regenerating spruce, are covered with grasses or moss.

There are two bare rocks off the west end, and one off the east end of the island between Saunders and Helgesen islands.

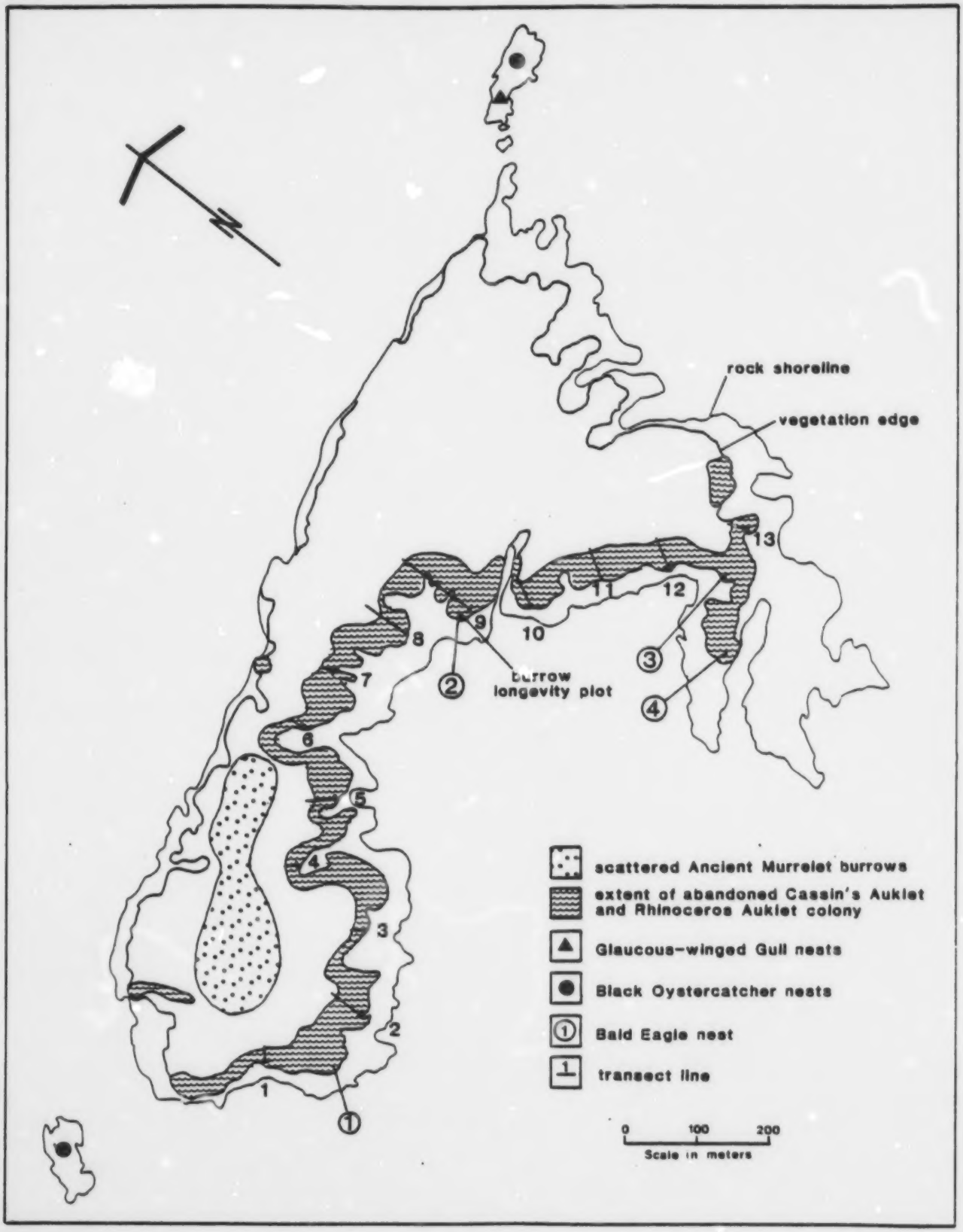


Figure WM020-1. Seabird colony areas and transect locations on Saunders Island in 1986.

Table WM020-1. Transect parameters and extent of abandoned Cassin's Auklet and Rhinoceros Auklet colony on Saunders Island in 1986.

Transect	Bearing (°)	Total length (m)	Elevation Beg. (m)	Elevation End (m)	Elevation Max (m)	Average Slope (°)	Range of Slope (°)	Extent of burrows: Dist. along transect (m)	Extent of burrows: Dist. from nearest shore Min. (m)	Extent of burrows: Dist. from nearest shore Max. (m)	Extent of burrows: Range of elevation (m)
1	50	18	50	55	55	38	22-50	0-15	0	24	45-55
2	0	48	31	65	65	45	41-50	0-40	0	50	24-26
3	320	18	40	47	47	38	33-42	0-15	0	15	40-47
4	320	18	45	50	50	28	8-47	0-15	0	25	38-50
5	320	48	10	25	25	18	6-30	0-23	0	23	10-25
6	0	18	30	32	35	35	30-40	0-18	0	28	24-35
7	340	18	40	43	43	19	7-30	0-17	0	17	34-43
8	0	93	10	32	32	21	0-50	0-52	0	52	10-27
9	0	108	12	30	30	27	10-45	0-98	0	38	5-28
10	30	48	15	35	35	24	15-38	0-38	0	20	15-32
11	30	48	10	35	35	12	6-15	0-38	0	38	10-35
12	30	48	20	45	45	31	12-48	0-38	0	46	14-42
13	335	33	30	43	43	27	18-35	0-22	0	24	30-39

Nesting species:

Black Oystercatcher: Five pairs of Black Oystercatchers were nesting on the rocks off the west and east ends. On 29 May, we found 3 nests on the closest west rock: 1 with 2 eggs, 1 with 1 egg, and 1 with 1 fresh plus 2 older broken eggs nearby; and 1 nest with 2 eggs on the east rock. One pair was present on the outer west rock, but we could not land due to swell size. Nests on the inner west rock were made of rock chips on rock; the one on the east rock was made of rock chips on a worn dirt bowl in a small grass tussock.

Glaucous-winged Gull: On 29 May, there were 12 adults on territories on the outer west rock. We were unable to land to check for nests. On the east rock there was one pair of adults just beginning nest building.

Pigeon Guillemot: We saw 8 Pigeon Guillemots along the shore of the east rock at 1100 h on 25 May. On 29 May at 1900 h, there were 2 birds near the east rock, and 4 around the outer west rock. We suspected about 6 pair nesting on these rocks later in the season.

Ancient Murrelet: A few Ancient Murrelet burrows were found in interior areas towards the west end. We found 4 eggshells, 1 fresh pair of wings, and 3 feather piles, indicating that some birds were attending the colony. As other species had apparently abandoned their colony areas (see below), these few Ancient Murrelets were the only burrow nesting seabirds still attempting to nest on Saunders Island in 1986. We suspect there were no more than 50 pairs.

Cassin's Auklet: There were Cassin's Auklet sized burrows mixed with Rhinoceros Auklet sized burrows all along the south side of the island within 50 m of shore (Figure WM020-1, Table WM020-1). Two small pockets of burrows were found on the north side on a nearshore knoll and an open ridge. Burrows were most abundant along the vegetation edge. Cassin's Auklet sized burrows were found under grass tussocks, into the open slope, under tree roots and logs. Rhinoceros Auklet sized burrows were found in the open slope, under logs, grass tussocks and tree roots and bases (Table WM020-2). There was no sign of present use at any of these burrows, and many had vegetation carpeting entrances and tunnels. A subjective scale of 1 to 4 was used to describe the extent of vegetation growth within burrow entrances (Table WM020-3). Fifty-nine percent of the Cassin's Auklet sized burrows and thirty-six percent of the Rhinoceros Auklet sized burrows had entrances that were either partially or almost completely obscured by vegetation growing in the entrances and tunnels. We found eggshell fragments of both species and old feathers in burrows, and some entrances still appeared worn, suggesting that some burrows had been occupied within the last year or two. We encountered very little sign of either recent or past predation (7 Rhinoceros Auklet skulls, 5 old feather piles and 1 Cassin's Auklet skull and 1 partial skeleton with a few feathers attached found in 1 burrow), though we suspected the presence of marten or raccoon on the island (see below). We ran transects through this colony to obtain an estimate of the previous size of the colony. We differentiated between Cassin's Auklet and Rhinoceros Auklet burrows on the basis of size (burrows greater than 12 cm in diameter were identified as Rhinoceros Auklet).

Table WM020-2. Habitat locations of Cassin's Auklet and Rhinoceros Auklet burrow entrances on Saunders Island in 1986.

Habitat location	Cassin's Auklet		Rhinoceros Auklet	
	Number of burrows	Percent of Total	Number of burrows	Percent of total
Tree base	1	2	4	12
Live tree roots	6	15	3	9
Dead tree roots	0	0	2	6
Log	4	10	6	18
Grass tussock	18	44	5	15
Open ground	1	2	1	3
Into bank	11	27	13	38
Totals	41		34	

Table WM020-3. Degree of vegetation regrowth in Cassin's Auklet and Rhinoceros Auklet burrow entrances on Saunders Island in 1986.

	Cassin's Auklet		Rhinoceros Auklet	
	Number of burrows	Percent of total	Number of burrows	Percent of total
Worn	2	5	12	36
Vegetation beginning to grow in entrance	15	37	9	27
Partially obscured by growing vegetation	11	27	6	18
Almost obscured by growing vegetation	13	32	6	18
Totals	41		33	

Number of sample plots: 34 (306 m^2 - 0.4% of colony)

Average Density: 1340 $\pm$ 360 burrows/ha (Table WM020-4)

Colony Area: 8.1 ha

Total Burrows: 10,830 $\pm$ 2909

Rhinoceros Auklet: See Cassin's Auklet account above.

Number of sample plots: 34 (306 m^2 - 0.4% of colony)

Average Density: 1111 $\pm$ 345 burrows/ha (Table WM020-5)

Colony Area: 8.1 ha

Total Burrows: 8,979 $\pm$ 2788

Predation: As noted above, few signs of predation were found. In addition to that mentioned, we found 2 Sooty Shearwater and 2 Glaucous-winged Gull feather piles. We did find a number (15) of burrows that had been dug up in the past one or two years. Entrances had been dug open, and small, shredded and torn roots were evident. There were river otter runs and small dens around the island. Most otter scats contained only fish remains, but a few contained feathers (one fresh). On one of the southeast knobs, we discovered an old pile of scats under a root cavity above a steep grassy bluff (20 m elevation). There were about 10 scats (5-6 cm x 2 cm): 4 with shells (crab, periwinkle, etc.), others with some feather or mostly feather. The scats with feathers were blackish or green; with shells they were whitish. They may have been old river otter scat, but they were not typical. Raccoon was a second suspect. In the sand on the beach on the north side, we observed many tracks of an unidentified mammal. The prints of fore and hind paws were similar, had five toes, with nails showing, and measured 4.5 cm wide at the widest point (2.2 cm across pad), and 4.2 cm long (3.6 cm excluding nails). The distance between prints varied from 21-45 cm. The tracks were too small to be adult river otter. We suspect they may have been marten tracks. The animal had been digging amphipods out of the sand.

In 1987, R. Hoar (pers. comm.) revisited the island and reported tracks of three raccoons on the beach.

Remarks: This island should be surveyed for the presence of mammalian predators. Its closeness to other colonies may indicate future problems at those sites.

Associated species:

Pelagic Cormorant - 29 May: 2 adults with breeding patches and 10 immatures roosting on outer west rock. Two adults flew into a cave on Moresby Island just north of this rock.

Table WM020-4. Number of Cassin's Auklet sized burrows in 3x3 m plots along transects on Saunders Island in 1986. Plots considered outside the colony are indicated by a dash.

Plot	Transect												
	1	2	3	4	5	6	7	8	9	10	11	12	13
1	0	0	6	1	1	1	2	4	1	4	0	2	0
2	-	0	-	-	0	0	0	7	5	3	1	0	0
3		0			-			1	0	0	0	1	-
4		-			-			0	0	-	-	-	
5								-	0				
6								-	1				
7								-	0				
8									-				

Table WM020-5. Number of Rhinoceros Auklet sized burrows in 3x3 m plots along transects on Saunders Island in 1986. Plots considered outside the colony are indicated by a dash.

Plot	Transect												
	1	2	3	4	5	6	7	8	9	10	11	12	13
1	0	9	1	4	4	1	0	1	0	1	2	2	3
2	-	0	-	-	0	1	0	1	0	2	0	0	1
3		0			-			0	0	1	0	0	-
4		-			-			0	0	-	-	-	
5								-	0				
6								-	0				
7								-	0				
8									-				

Bald Eagle - 4 nests:

1. Southwest corner. 25 m high in 30 m tree. Appears unused - branches broken. 1 adult nearby.

2. East side of mid-south bay on nose of ridge. 15 m high in 25 m spruce, 5 m from shore. No birds present. Salmonberry growing from edges.

3. Southeast knob on southeast corner. 20 m high in 40 m spruce at north end of knob. Adult sitting in nest on 13 May.

4. 100 m from #3 on outer south knob at southeast corner. 25 m high in 28 m spruce near the south end of the knob. 1 adult between #3 & 4. Nests #3 & 4 probably belong to the same pair.

Northwestern Crow
Common Raven

Hair Seal - 17 on southeast tidal shelf on 13 May.
River Otter
Marten - suspected from tracks
Raccoon - tracks in 1987
Sitka Deer

Other sightings:

Whimbrel - 8
Herring/Thayer's gulls - 5 roosting on outer rock
Northern Flicker
Chestnut-backed Chickadee
Winter Wren
Varied Thrush - one nest with 3 eggs found 25 May.
Orange-crowned Warbler
Townsend's Warbler

WM-030 HELGESEN ISLAND 103 F/1

Including the small island off northeast side, which we named "Little Helgesen".

Location: In the northwest corner of Englefield Bay. 53°01'50"N 132°26'30"W

Land status: Provincial Crown Land.

Date of survey: 7,11,21 May (exploration); 10,14,17,19,20 May (transects); 20,22,26,29 May 1986 (occupancy). Work on many of these dates was only for parts of the day by one or two observers.

Colony access: Landing beach on the northeast corner. Landing was difficult at high tides and in rough sea conditions. Drop-off by boat required to reach the southern section of the island.

Base camp: We camped in the small bay on the northeast corner from 5-30 May 1986. Tent sites were limited. Water was obtained from the adjacent bay on Moresby Island. We rigged an anchoring system in the bay to store the boats.

Observers: M. Lemon, M. Rodway, D. Powell, A. Eisenhawer, D. Garnier, D. Grinnell.

Census method: 43 quadrats (5x5 m) spaced 30 m apart (for Ancient Murrelets) plus 84 quadrats (3x3 m) spaced 15 m apart (for Cassin's and Rhinoceros Auklets) along 22 transects on the main island, and 18 quadrats (3x3 m) spaced 15 m apart along 4 transects laid 75 m apart on the "Little Helgesen" (Fig. WM030-1; Table WM030-1 and WM030-2). On the main island, transects 1-3, which sampled a patch of Ancient Murrelet burrows, were spaced 100 m apart. Transects 4-22 were run through mixed colony and were spaced 75 m apart. Rhinoceros Auklets and Cassin's Auklets were sampled along each of these transects, while Ancient Murrelets were sampled on alternate ones on the northern and southern sections of the island. On transects where we sampled for Ancient Murrelet burrow density, the 5x5 m quadrats overlaid the 3x3 m plots used for Rhinoceros Auklet and Cassin's Auklet burrow density, at 30 m spacings.

In some areas on the east side of the south end of the island burrowing occurred in sporadic pockets that were too small to map accurately. To calculate colony area in those locations we measured the overall area and estimated the percentage that was used for burrowing (Fig. WM030-1 and WM030-2).

In addition to determining the occupancy of burrows in quadrats along the transect lines, we supplemented our sample with four occupancy plots. Plot 1 was located on the northwest point near the beginning of transect 4. Plot 2 was situated on a forested ridge on the east side of the south section of the island, plot 3 was on a grassy slope under an open spruce forest on the east side of the middle section and plot 4 was located on the west side immediately north of the middle section (Fig. WM030-1).

Description: Like the rest of the islands in Englefield Bay, Helgesen has precipitous edges cut by deep gorges and crevices. One impassable gorge cuts east-west across the island, isolating the southeastern third of the island from the rest. This gorge, and a narrow saddle further north, separate the island into three major segments. The middle hump is smaller and lower than the south and north sections. The whole island has an area of 51 ha, and reaches its maximum elevation of 114 m on the southern segment. There are cliffs and rock bluffs around all sides of the island. Those along the south and west sides are mostly exposed, occurring at the shore, while along the east side there are a number of recessed cliffs fronted by forested habitat. Except for the small area behind the only beach on the island at the northeast corner, slopes from shore are steep in all areas. "Little Helgesen", off the east side, is a 2.7 ha, cigar-shaped island. It has steep sides, but only rises to approximately 15-20 m elevation.

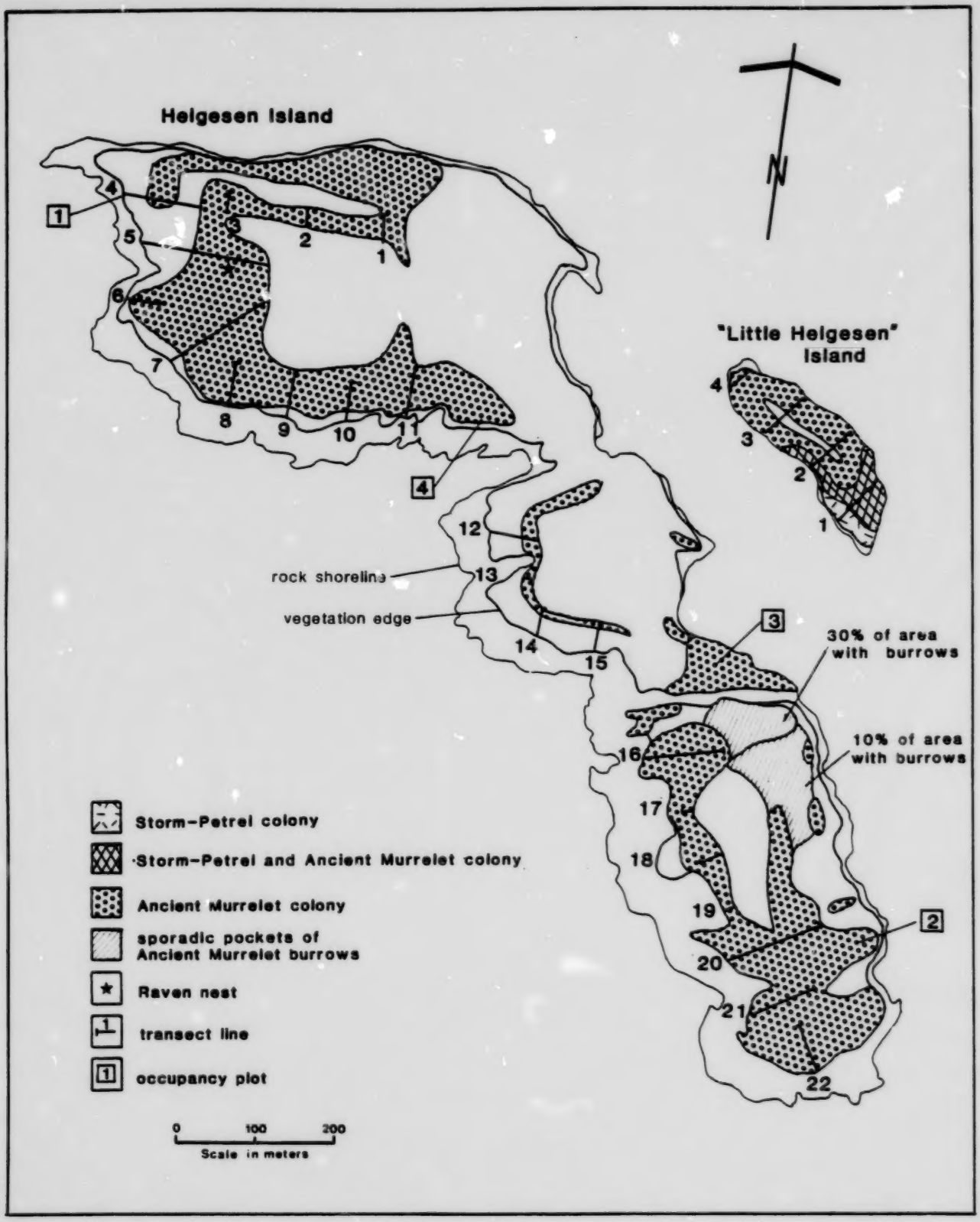


Figure WM030-1. Storm-petrel and Ancient Murrelet colony areas and transect locations on Helgesen Island in 1986.

Table WM030-1. Transect parameters on Helgesen Island in 1986.

Transect	Bearing (°)	Total length (m)	Elevation			Average slope (°)	Range of slope (°)
			Beg. (m)	End (m)	Max. (m)		
1	185	65	58		72	30	20-38
2	185	35	72	72	72	35	33-37
3	185	35	58	61	61	20	0-40
4	95	90	8			27	15-40
5	95	185	4	68	68	20	0-45
6	95	54	4	25	25	28	10-38
7	50	185	8	63	63	21	5-50
8	5	78	15	55	55	33	5-45
9	5	95	25	68	68	30	17-52
10	5	55	20	35	35	18	0-30
11	5	95	10	55	55	50	40-65
12	95	78	20	60	60	38	25-45
13	95	18	60	70	70	38	25-50
14	5	48	20	45	45	28	10-45
15	5	48	30	47	47	29	5-55
16	75	104	48	80	80	25	12-44
17	75	23	90	98	98	37	33-44
18	60	35	100	114	114	26	8-50
19	60	18	90	100	100	40	30-50
20	60	155	30	52	80	33	15-45
21	60	93	15	61	63	26	10-45
22	330	78	15	45	45	27	10-45

Table WM030-2 Transect parameters and extent of storm-petrel, Ancient Murrelet and Rhinoceros Auklet colonies on "Little Helgesen" Island in 1986.

Transect parameters					Extent of colony								
					Storm-petrel			Ancient Murrelet			Rhinoceros Auklet		
						Dist. from nearest shore			Dist. from nearest shore			Dist. from nearest shore	
Transect	Bearing (°)	Total length (m)	Average Slope (°)	Range of Slope (°)	Dist. along transect (m)	Min. (m)	Max. (m)	Dist. along transect (m)	Min. (m)	Max. (m)	Dist. along transect (m)	Min. (m)	Max. (m)
1	40	81	33	10-55	0-81	0	40	30-81	0	40	0-81	0	40
2	40	61	13	5-25	0-10	0	10	0-22 37-61	0	24	0-10	0	10
3	40	66	8	2-25	-	-	-	0-22 37-66	0	29	-	-	-
4	40	28	25	5-45	-	-	-	0-28	0	14	-	-	-

The stands of mature forest on Helgesen are a mix of spruce (mostly 0.7-0.9 m dbh), hemlock (mostly 0.5-0.7 m dbh) and redcedar (0.5 m dbh and occasional 1.5 m dbh), with spruce more abundant near shore, especially on the more exposed southwest side. Large tracts of forest have blown down and/or died at different periods in the past, and extensive areas are now covered with regenerating spruce of various ages. On the north section, much of the slope on the west and southwest sides, and the crest along the north end are covered with thick, 3-8 m tall spruce. Where the young spruce does not extend to shore, patches of grass or moss occur. On the northeast corner of this section a fresh swath of windfall has come down across the ridge-top. Lower slopes below the crest on the north side, are wet, with patches of devil's club (Oplopanax horridus), grass, and young spruce. The ground cover in open interior areas is moss or bare litter. There is an extensive grassy slope rising almost to the height of land on the west side of the saddle between the north and middle sections. On the middle hump, dense, 5 m tall spruce and some hemlock extend over much of the area above steep grassy slopes on the west side. Bare litter and mossy areas occur in the interior. There is a grassy and mossy ridge on the southeast corner of this section, otherwise the east slopes are precipitous, with some wet, lower areas.

Young spruce covers most of the south end of the southern section. It is larger on the southwest corner (5-8 m tall), getting smaller towards the top of the slope (1-3 m) where it mixes with hemlock. This smaller spruce extends around much of the upper east slopes. On the ridge crest, and the west slopes below the crest, are open grassy and mossy areas under mature hemlock (0.5-0.7 m dbh) and spruce (0.7 m dbh). Sitka Alder (Alnus sinuata) lines the top edges of cliffs in this area. The northern part of the south section rapidly steepens into the dissecting gorge. These steep, north facing slopes above the gorge, have a bare litter and moss understory. Towards the east side, the steep slopes become wet, with moss, liverworts, or grass growing over loose, easily eroded scree and soil. Frequent, small sections have sluffed, bringing down trees and causing small slides. Some drier areas occur on raised ridges.

The "Little Helgesen" is mostly open moss under mature forest.

Nesting species:

Storm-petrel: A small population of storm-petrels was nesting on the south end of the "Little Helgesen" island (Figure WM030-1, Table WM030-2). We found one possible storm-petrel burrow on the east side of the southern section of the main island, but no other sign of nesting was found on Helgesen, though we freqently heard Fork-tailed Storm-Petrels calling at night, flying around the top of the slopes near the saddle south of our camp. We frequently heard them flying and calling around the "Little Helgesen" island.

Number of sample plots:	7 (63 m^2 - 1.0% of colony)
Average Density:	310 ± 200 burrows/ha (Table WM030-3)
Colony Area:	0.66 ha
Total Burrows:	203 ± 131

1986 Occupancy Rate: No occupancy was determined.

1986 Nesting population: Using the median British Columbia occupancy rate of 91%, we estimated 184 ± 119 pairs nesting.

Table WM030-3. Number of storm-petrel burrows in 3x3 m plots along transects on "Little Helgesen" Island in 1986. Plots considered outside of the colony are indicated by a dash.

Plot	Transect			
	1	2	3	4
1	0	0	-	-
2	0	-	-	-
3	0	-	-	
4	1	-	-	
5	1	-	-	
6	0			

Ancient Murrelet: We found Ancient Murrelets burrowing over extensive areas along the west side and around the south end of Helgesen Island (Table WM030-4) in association with Rhinoceros Auklets and Cassin's Auklets. They occurred in a narrow fringe along the top of the slope at the north end of the island, and on the upper west slope of the middle section. Burrows were scattered in drier pockets on the east side of the southern and middle sections. Most of the "Little Helgesen" island was being used by Ancient Murrelets (Figure WM030-1, Table WM030-2).

Burrows were located in open, grassy habitat near shore, in mossy or bare litter interior areas under mature forest, and under stands of varying ages of regenerating spruce forest. Ancient Murrelet burrowing habitat extended as far as 90 meters into stands of 3-5 m tall spruce saplings with a canopy of 75% on the west side of the north section of the island. On the southern section of the island, the colony extended through 140 m of regenerating spruce (Table WM030-5). They occurred from 0 m to 165 m from shore (though generally the colony began 15 m from shore), and from 6 m to 112 m in elevation on slopes of 13 to 50° (average = 29°) (Table WM030-4). Entrances were under roots, logs, stumps and open ground and slope (Table WM030-6). The mean length of a sample of 26 burrows (from the occupancy plots) was 90 ± 10 cm.

Table WM030-4 Extent of Ancient Murrelet, Cassin's Auklet and Rhinoceros Auklet colonies on Helgesen Island in 1986. "+" indicates that the Ancient Murrelet colony extends further than the distance surveyed on the Rhinoceros Auklet transects.

Transect	Ancient Murrelet					Cassin's Auklet					Rhinoceros Auklet				
	Dist. along transect (m)	Dist. from nearest shore Min. (m)	Dist. from nearest shore Max. (m)	Range of elevation (m)	Average slope (°)	Dist. along transect (m)	Dist. from nearest shore Min. (m)	Dist. from nearest shore Max. (m)	Range of elevation (m)	Average slope (°)	Dist. along transect (m)	Dist. from nearest shore Min. (m)	Dist. from nearest shore Max. (m)	Range of elevation (m)	Average slope (°)
1	0-40	105	145	58-72	30	-					-				
2	0-25	98	123	72	33	-					-				
3	0-35	70	105	58-61	20	-					-				
4	37-80	37	80	17-25	26						0-67	0	67	8-25	27
5	74-180	60	165+	35-68+	16						0-48	0	33	4-15	15
6	10-54+	10	54+	6-25+	28						0-50	0	50	4-25	28
7	22-165+	22	165+	20-62+	23						0-67	0	67	8-49	36
8	0-75+	0	75+	15-55+	33						0-67	0	67	15-52	38
9	15-75+	15	75+	33-62+	35						0-52	0	52	25-52	33
10	15-55+	15	55+	25-35+	13						0-55	0	55	20-35	18
11	15-90	15	90	20-55	50						0-52	0	52	10-37	54
12	51-78	20	25	46-60	42						0-70	0	30	20-55	36
13	0-18	15	33	60-70	38						0-18	0	33	50-70	38
14	30-37	30	37	35-40	35						0-37	0	37	20-40	30
15	37-45	37	45	45-47	15						0-45	0	45	30-47	29
16	0-107	0	79	48-80	25	0-22.5	0	25.5	48-57	32	-				
						90-107	65	79	80	33					
17	0-15	0	20	87-98	37	0-15	0	20	87-98	37	-				
18*	0-35	75	100	?-112	35	0-35	75	100	?-112	35	0-35	75	100	?-112	35
19	0-13	10	23	90-100	40	-					0-13	10	23	90-100	40
20	0-140	0	103+	30-80	33	0-72	0	72	30-70	36	0-36	0	36	30-52	39
21	0-93	0	73+	15-63	26	0-75	0	55+	15-60	29	0-75	0	55+	15-60	29
22	0-78	0	83+	15-45	27	0-78	0	83+	15-45	27	0-78	0	83+	15-45	27

* transect was begun 10 back from the edge of the bluff.

Table WM030-5. Extent of colony within young, regenerating forest along transects on Helgesen Island in 1986. Regenerating species are predominantly spruce with some hemlock. "+" indicates extent is greater than that shown.

	Regenerating forest				Extent of burrowing from beginning of regenerating forest (m)		
Transect #	Beginning (m)	End (m)	Range of height (m)	Average canopy(%)	Ancient Murrelet	Rhinoceros Auklet	Cassin's Auklet
4	37	120	3-4	30	43	30	-
6	0	50+	10-15	65	50+	50	-
7	35	165	3-5	75	90+	32	-
9	0	60	2-10	40	60	52	-
11	15	60	3-5	45	45	37	-
12	15	30	5-10	95	-	15	-
13	0	18+	3-5	35	18	18	-
14	45	45+	3	30	-	-	-
15	45	45+	2	40	-	-	-
18	45	45+	-	-	-	-	-
19	0	13+	3-8	70	13	13	-
20	0	140+	3-9	75	140	36	72
22	20	78+	1-6	55	58	58	58

Table WM030-6. Habitat locations of Ancient Murrelet, Cassin's Auklet and Rhinoceros Auklet burrow entrances on Helgesen and "Little Helgesen" islands in 1986.

	Ancient Murrelet		Cassin's Auklet		Rhinoceros Auklet	
Location	Number of Burrows	Percent of Total	Number of Burrows	Percent of Total	Number of Burrows	Percent of Total
Tree base	3	5	1	4	11	8
Tree roots (live)	18	28	3	13	23	18
Stump	18	28	1	4	8	6
Tree roots (dead)	6	9	6	26	13	10
Fallen tree/log	8	13	3	13	20	15
Rock	0	0	0	0	3	2
Grass tussock	1	2	0	0	19	15
Open ground	5	8	4	17	1	1
Into bank	5	8	5	22	32	25
Total	64		23		130	

Number of sample plots:

Main island:	31 (775 m^2 - 0.5% of colony - plots 5x5 m)
"Little Helgesen":	14 (126 m^2 - 0.8% of colony - plots 3x3 m)

Average Density:

Main island:	700 $\pm$ 140 burrows/ha (Table WM030-7)
"Little Helgesen":	860 $\pm$ 330 burrows/ha (Table WM030-8)

Colony Area:

Main island:	15.4 ha
"Little Helgesen":	1.6 ha
Total:	17.0 ha

Total Burrows:

Main island:	10,786 $\pm$ 2157
"Little Helgesen":	1,368 $\pm$ 525
Total:	12,154 $\pm$ 2220

1986 Occupancy Rate: Of 27 burrows whose contents we determined, 17 were occupied this season, giving an occupancy rate of 63 $\pm$ 8%. At the time these burrows were checked, 53% (9 of 17) contained incubating adults (1 with 1 egg, 8 with 2 eggs). The rest held cold eggs (Table WM030-9).

1986 Nesting Population:

Main island:	6,795 $\pm$ 1597 pairs.
"Little Helgesen":	862 $\pm$ 346 pairs.
Total:	7,657 $\pm$ 1634 pairs.

Cassin's Auklet: Cassin's Auklets were nesting primarily on the south section of Helgesen Island. The highest burrowing density occurred on the south end in open, mossy patches on the bottom edges of the slope above the shore bluffs, and in bare litter ground under the larger regenerating spruce (Table WM030-4). Burrows were scattered in drier areas on the east slopes of the southern portion and occurred very sporadically over most of the west side of the rest of the island (Figure WM030-2). Burrows were located under tree roots, logs and stumps and into the open ground and slope (Table WM030-6). They occurred on slopes of 8 to 50° (average = 33°), extending from 0 m to 100 m from shore vegetation edge and from 15 to 112 m in elevation (Table WM030-4). Cassin's Auklets were burrowing in a small area on the south end of the "Little Helgesen" island. Average slope there was 28°.

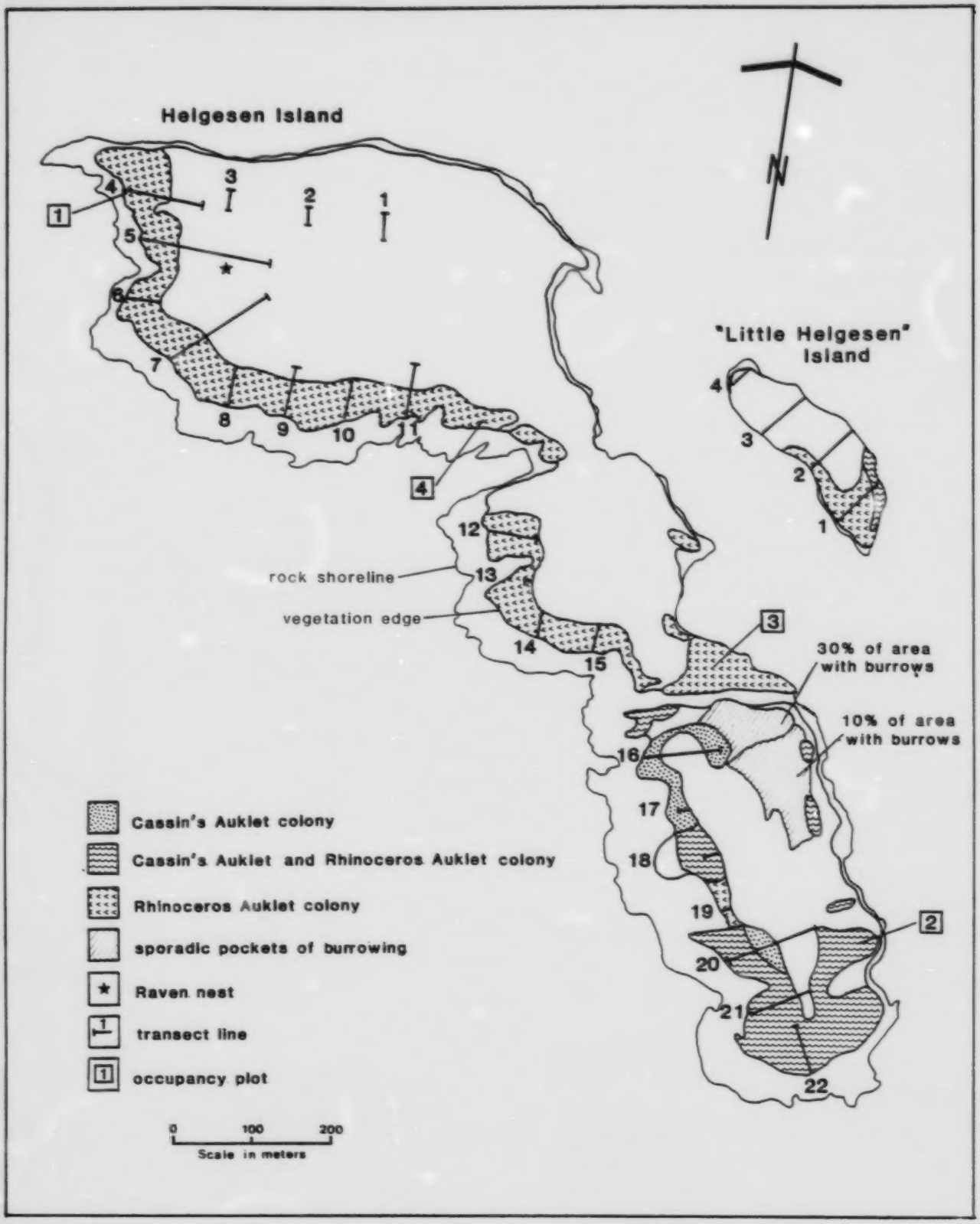


Figure WM030-2. Cassin's Auklet and Rhinoceros Auklet colony areas and transect locations on Helgesen Island in 1986. Cassin's Auklets are not mapped on the northern two-thirds of the island where they occur very sporadically. See text.

Table WM030-7. Number of Ancient Murrelet burrows in 5x5 m plots along transects on Helgesen Island in 1986. Plots considered outside the colony are indicated by a dash.

Plot	Transect										
	1	2	3	5	7	9	11	16	18	20	22
1	7	5	2	-	-	-	-	2	0	0	1
2	1	-	1	-	1	0	1	3	0	0	2
3				-	1	5	0	4		0	0
4				2	5	-	-	4		3	
5				0	1					1	
6				0	2					-	
7				-	-						

Table WM030-8. Number of Ancient Murrelet burrows in 3x3 m plots along transects on "Little Helgesen" Island in 1986. Plots considered outside of the colony are indicated by a dash.

Plot	Transect			
	1	2	3	4
1	-	1	2	0
2	-	0	0	0
3	0	-	-	
4	1	0	0	
5	1	1	1	
6	4			

Table WM030-9. Occupancy of Ancient Murrelet burrows along transects and in occupancy plots on Helgesen and "Little" Helgesen islands in 1986.

Date	Location: Tran	Location: Plot	Contents: Empty	1 cold egg	2 cold eggs	Adult + 1 egg	Adult + 2 eggs	Chicks	Total occupied	Total known
"Little" Helgesen Island										
11 May	1	6		1*			1		2	2
11 May	2	5					1		1	1
Helgesen Island										
14 May	5	1	1						0	1
17 May	7	4	1						0	1
17 May	8	1			2				2	2
17 May	9	3	1						0	1
18 May	16	3			1				1	1
19 May	1	1	1						0	1
19 May	1	2					1		1	1
19 May	2	1					1		1	1
20 May	11	4[a]	1						0	1
20 May	20	2[a]		1					1	1
20 May	20	4[b]	1						0	1
20 May	21	7	1	1					1	2
Occupancy plots										
26 May		2	1			1	1		2	3
29 May		3	2	2			3		5	7
Totals			10	5	3	1	8		17	27

* Burrow was dug open.
a In Rhinoceros Auklet plot.
b In Ancient Murrelet plot.

Number of sample plots:

South end: 22 (198 m^2 - 0.5% of colony)
Rest of colony: 47 (423 m^2 - 0.7% of colony)

Average Density: Separate density calculations were made for the colony area on the south end of the island (Tran 16-22), and for the rest of the colony area in which burrowing was very sparse (Tran 4-15).

South end: 1060 ± 430 burrows/ha (Table WM030-10)
Rest of colony: 47 ± 33 burrows/ha

Colony Area:

South end: 4.4 ha
Rest of colony: 5.9 ha (includes 0.15 ha on "Little Helgesen")
Total: 10.3 ha

Total Burrows:

South end: 4705 ± 1909
Rest of colony: 280 ± 196
Total: 4985 ± 1919

1986 Occupancy Rate: We determined the contents of only 4 burrows, 2 of which were occupied. One burrow contained an incubating adult; in the other we only reached the adult. This was too small a sample to calculate an occupancy rate.

1986 Nesting Population: Using the median B.C. occupancy rate of 75%, we estimated 3739 ± 1439 pairs nesting.

Table WM030-10. Number of Cassin's Auklet burrows in 3x3 m plots along transects on Helgesen Island in 1986. Plots considered outside the colony are indicated by a dash.

Plot	Transect																		
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	1	0	0	0	0	0	0	0	0	0	0	0	4	1	0	-	1	0	6
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	0	0
3	0	0	0	0	0	0	0	0	0	-	0	0	-	-	-		0	0	1
4	0	0	0	0	1	0	0	0	0		-	-					3	0	0
5	0	-	-	-	0	-	-	-	0								0	0	0
6	-				-				-								-	-	5

Rhinoceros Auklet: In the southern section of the island, the distribution of Rhinoceros Auklets was very similar to that of Cassin's Auklets, except for two small areas on the west side where they were absent (Figure WM030-2). Rhinoceros Auklet colony was extensive and dense along the south and west

facing sides of the north section where Cassin's Auklets were only occasionally encountered. The overall density of Rhinoceros Auklet burrows was much higher than Cassin's Auklet's, as they were uniformly abundant over most of their colony area. Burrows were most frequent in open mossy or grassy areas on the lower edges of the slopes, but they extended as much as 58 m into thick young spruce (Table WM030-5). They ranged from 4 to 112 m in elevation, and from 0 to 100 m from shore (though most were within 60 m of shore), on slopes of 5 to 65° (average = 32°). Burrows were located under tree bases and roots, logs, open slopes, grass tussocks and stumps (Table WM030-6). On the "Little Helgesen" island, Rhinoceros Auklets were nesting around the south end. The mean length of a sample of 12 burrows was 163 ± 21 cm.

Number of sample plots:

Main island:	65 (585 m^2 - 0.6% of colony)
"Little Helgesen":	7 (63 m^2 - 1.0% of colony)

Average Density:

Main island:	2000 ± 330 burrows/ha (Table WM030-11)
"Little Helgesen":	1890 ± 570 burrows/ha (Table WM030-12)

Colony Area:

Main island:	10.2 ha
"Little Helgesen":	0.7 ha
Total:	10.9 ha

Total Burrows:

Main Island:	20,307 ± 3351
"Little Helgesen:"	1,238 ± 373
Total:	21,545 ± 3372

1986 Occupancy Rate: Seven of 17 known burrows were occupied at the time of our survey. In 5 of these we found adults incubating eggs; in the other 2, we could only reach the adult (Table WM030-13). In three of the ten empty burrows fresh moss nesting materials were noted. At this date it is likely that many birds had not yet begun nesting, and the actual occupancy rate would be higher.

1986 Nesting Population: Using the median B.C. occupancy rate of 77% we estimated 16,590 ± 2596 pairs nesting.

Nocturnal Activity: Our camp was not in a dense part of the colony, but we regularly heard a few birds calling and flying in at night. By 2300 h early in May, there were usually Fork-tailed Storm-Petrels calling, mostly from the direction of "Little Helgesen", and some Ancient Murrelets were flying in. Calling by Fork-tailed Storm-Petrels, Ancient Murrelet, and Cassin's Auklets was more abundant from 0030 to 0300 h. Rhinoceros Auklets began calling later in the night. We heard them at 0230 h on 29 May.

Table WM030-11. Number of Rhinoceros Auklet burrows in 3x3 m plots along transects on Helgesen Island in 1986. Plots considered outside the colony are indicated by a dash.

Plot	Transect																		
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	6	3	0	10	0	5	3	1	3	0	4	2	-	-	0	5	12	0	1
2	4	3	0	3	3	0	2	2	3	2	6	2	-	-	1	-	0	0	4
3	0	0	0	1	2	0	1	2	2		5	1	-		-		0	0	0
4	0	0	0	0	2	2	0	0	2		-	-					-	0	0
5	0			1	2	-		-	4								-	0	0
6	-			-	-				-									-	1
7																		-	

Table WM030-12. Number of Rhinoceros Auklet burrows in 3x3 m plots along transects on "Little Helgesen" Island in 1986. Plots considered outside of the colony are indicated by a dash.

Plot	Transect			
	1	2	3	4
1	4	0	-	-
2	3	-	-	-
3	1	-	-	
4	1	-	-	
5	2	-	-	
6	1			

Table WM030-13. Occupancy of Rhinoceros Auklet burrows along transects and in occupancy plots on Helgesen Island in 1986.

Date	Location		Contents					
	Tran	Plot	Empty	Cold egg	Adult + egg	Adult +?	Total occupied	Total known
14 May	5	1			1		1	1
14 May	5	2	1				0	1
17 May	7	1	1				0	1
17 May	8	2	1				0	1
20 May	10	2	1				0	1
20 May	20	1[a]				1	1	1
20 May	20	1[b]				1	1	1
20 May	22	1	1				0	1
Occupancy Plots								
20 May		4	1				0	1
22 May		1	1		3		3	4
26 May		2	2				0	2
29 May		3	1		1		1	2
Totals			10		5	2	7	17

[a] In Rhinoceros Auklet plot.
[b] In Ancient Murrelet plot.

Predation: During our exploration, evidence of predation on Ancient Murrelets was most abundant (96 feather piles, 23 pairs of attached wings, 34 single wings, and 22 eggshells), with less evidence of predation on Rhinoceros Auklets (19 feather piles and 1 carcass), and Cassin's Auklets (3 feather piles, 1 single wing, and 2 eggshells). We also found 1 Black-legged Kittiwake feather pile. At the site of the Common Raven nest on the northwest corner of the island, we found 14 pairs of the attached wings and 30 of the single wings of Ancient Murrelets listed above. A portion of these; 9 pairs of wings and 10 single wings of Ancient Murrelets was found together with 2 sets of adult Rhinoceros Auklet mandibles and 10 abalone shells in one pile in a small seepage stream near the nest tree. On our initial exploration, we also recorded two burrows that had been dug open. On 'Little Helgesen' Island we found four Ancient Murrelet feather piles and one dug-up burrow on our exploration. Eleven Bald Eagles pellets composed of feathers were found.

Along the transects, depredated remains of Ancient Murrelets and Rhinoceros Auklets were recorded (Table WM030-14). In the 31 surveyed plots in Ancient Murrelet colony area, there were six feather piles and two depredated eggs. This gives a mean density of 77 $\pm$ 29 feather piles/ha and 25 $\pm$ 18 eggshells/ha. Extrapolating this over the Ancient Murrelet colony area gives 1186 $\pm$ 447 depredated birds and 385 $\pm$ 277 depredated eggs.

Within the 65 (3x3 m) surveyed plots in the Rhinoceros Auklet colony area there was a total of 4 feather piles, giving a density of 68 $\pm$ 33 feather piles/ha. Extrapolating over the Rhinoceros Auklet colony area gives an estimate of 690 $\pm$ 335 depredated birds.

Associated species:

Bald Eagle - 5 immatures on 7 May. No nests were found.
Peregrine Falcon - 1
Black Oystercatcher - 2 on rocks on the west side on 7 May
Marbled Murrelet - 3 in northeast bay on 27 May
Northwestern Crow - 10
Common Raven - 1 nest on northwest corner, 20 m high in 1.0 m dbh spruce, 120 m from shore . Seen feeding on Ancient Murrelet on 22 May. See predation account above for a list of avian remains found around the nest.

River Otter - trails and scats on Helgesen and "Little" Helgesen I. active den on north point of "Little" Helgesen.
Slugs - lots of albinos
Sitka deer - fecal pellets throughout

Table WM030-14. Depredated remains of Ancient Murrelets, Rhinoceros Auklets, and Cassin's Auklets in plots along transects on Helgesen Island in 1986. Plots along transects for Ancient Murrelets (A) are 5x5 m. Plots along transects for Rhinoceros Auklets (R) are 3x3 m.

Location			ANMU feather pile	ANMU single wing	ANMU depredated egg	RHAU feather pile	RHAU skull or sternum	RHAU single wing	CAAU feather pile	Raptor pellet (with feathers)
Tran	Plot	Date								
1	1-A	19 May	1							
2	1-A	19 May			1					
3	1-A	19 May	1							
4	1-R	10 May				1				
4	3-R	10 May					1			
4	5-R	10 May	1	2						
5	1-R	14 May				1				
5	3-R	14 May	1							
5	2-A	14 May	1							
5	4-A	14 May	1		1					
5	5-A	14 May	1							
7	2-R	17 May				1				
7	1-A	17 May	2		1					1
7	5-A	17 May								1
9	3-A	17 May	1							
11	3-R	20 May				1				
11	4-R	20 May			1					
12	5-R	19 May					1			
12	6-R	19 May			1					
16	3-A	18 May								1
19	2-R	20 May								1
20	4-A	20 May	1							
21	1-R	20 May								1
21	2-R	20 May						1		
21	5-R	20 May								1
21	7-R	20 May	1							
22	1-R	20 May								1
22	6-R	20 May							1	
22	3-A	20 May							1	

Other sightings:

Shoveller - 2 on 7 May
Wandering Tattler - 1 on 20 May
Whimbrel - 2 on 14 May
Rufous Hummingbird
Red-breasted Sapsucker
Hairy Woodpecker
Northern Flicker - 1 nest on west side in 15 m spruce snag.
Adult flew from nest on 17 May.
Western Flycatcher - 6 May
Chestnut-backed Chickadee
Winter Wren
Swainson's Thrush - singing on 30 May
Hermit Thrush
Varied Thrush
Orange-crowned Warbler
Townsend's Warbler
Fox Sparrow
Dark-eyed Junco
Red Crossbill

Sightings in the bay west of Boomchain Bay, north of Helgesen I.

Green-winged Teal - 17 on 11 May; 1 pair on 12 May.
Mallard - 1 male and 1 female on 11 May.
Harlequin Duck - 1 male and 1 female on 12 and 21 May;
2 pair on 29 May.
Common Merganser - 1 male and 3 females on 11 May; 1 pair on 12 May;
1 female on 21 and 29 May.
Bald Eagle - 5 adult and 1 immature on 11 May.
Short-billed Dowitcher - 3 on 11 and 12 May.
Belted Kingfisher - 1 male on 21 May.
American Robin - 1 on 29 May.

Hair Seal - 1 on 21 May.
Sitka deer - on 11 and 21 May.
Raccoon - on tidal flats on 12 May.

WM-040 WILLIE ISLAND 103 F/1

Location: South of Saunders Island in the northwest corner of Englefield Bay.
53°01'15"N 132°27'45"W

Land status: Provincial Crown Land.

Date of survey: 8 May, 1600-1800 h and 15 May 1986, 1045-1115 h.

Colony access: Drop-off from boat.

Observers: M. Rodway.

Census method: One 2 m wide strip transect run across the main section of the island from the west end to the east end at a bearing of 95°. Ancient Murrelets, Cassin's Auklets, and Rhinoceros Auklets were burrowing in the same areas. No burrow contents were determined. Burrows were differentiated by size, droppings, feathers, and regurgitated food.

Description: Willie is a steep-sided, dome-shaped island with a total area of 5.4 ha, and a maximum elevation of approximately 50 m. There is a small knob on the northeast corner separated from the main island by a cliff-faced gorge. The vegetation on the northeast knob and on the perimeter of the main island is predominantly Calamagrostis mixed with Angelica lucida, Saxifraga sp., Fritillaria camschatcensis, Montia sp., and other forbs. Soil in these areas is shallow. There is a stand of mature spruce on the top of the main section, and a few spruce grow on the small knob. Moss becomes more abundant under the spruce on the main section, with areas of bare litter occurring under a stand of younger spruce (10 cm dbh) on the east end. Patches of smaller (3-5 m tall) regenerating spruce occur around the edges where there are a number of windfalls and dead snags.

The lush grass and forb habitat has been heavily browsed and severely trampled by deer, especially on the northeast knob. There was no sign of storm-petrel burrows that had previously been recorded by BCPM crews in those areas.

Nesting species:

Storm-petrel: No sign of nesting was encountered (see above).

Pigeon Guillemot: There were 14 Pigeon Guillemots around the island on 7 May at 1100 h, and 25 on the shore rock on the east side of the island on 15 May at 1045 h.

Ancient Murrelet: Ancient Murrelet burrows were sparsely scattered over the main part of the island. We identified one burrow along the transect as Ancient Murrelet. We estimated a total of 20 burrows and 10 nesting pairs. No occupancy was determined.

Cassin's Auklet: We found 5 Cassin's Auklet burrows on the northeast knob under roots and rock which were protected from the erosion caused by the deer. We estimated less than 20 burrows in this area. Burrows had droppings and regurgitated food at their entrances. On the main portion, burrows were scattered over most areas with sufficient soil depth. Burrows were located primarily around roots, with a few occurring in open ground.

Average Density: We counted 11 Cassin's Auklet burrows on the strip transect. This transect sampled a 2 m x 35 m area of the colony (5%), giving an average density of 0.16 burrows/m^2.

Colony Area: 1400 m^2.

Total Burrows: 220 burrows.

1986 Occupancy Rate: No occupancy was determined though we attempted to reach the end of every burrow encountered.

1986 Nesting population: We estimated 170 pairs.

Rhinoceros Auklet: Rhinoceros Auklets were nesting in the same areas as Cassin's Auklets. They tended to be more abundant on the east and north sides than the west and south.

Average Density: We counted 5 burrows along the transect giving a density estimate of 0.07 burrows/m^2

Colony Area: 1400 m^2.

Total Burrows: 100.

1986 Occupancy Rate: No occupancy was determined though we attempted to reach the end of every burrow encountered.

1986 Nesting population: We estimated 80 pairs.

Predation: We found the following prey remains (feather piles) under the eagle nest: 2 Sooty Shearwater, 1 Black-legged Kittiwake, 1 gull, 1 Ancient Murrelet, and 2 Rhinoceros Auklet.

Associated species:

Double-crested Cormorant - 3 flying on 7 May.
Bald Eagle - 3 nests on the top: two 15 m high in 25 m spruce, and one 25 m high in 30 m spruce. The highest one was occupied this year.
Northwestern Crow - 10

Northern Sea-Lion - 7 off the west end.
Sitka Deer - heavy browsing (see above).

Other sightings:

Townsend's Warbler
Song Sparrow

WM-050 CARSWELL ISLAND 103 F/1

Location: On the north side of Englefield Bay off the mouth of Inskip Channel. 53°01'15"N 132°25'W

Land status: Provincial Crown Land.

Date of survey: 7 May, 1200 h (boat around the island), 11 May 1986, 1400-1800 h (exploration and partial count).

Colony access: Drop-off from boat.

Observers: D. Garnier, D. Grinnell, A. Eisenhawer (main survey), M. Lemon, M. Rodway (observations from boat).

Census method: Exploration and partial count.

Description: Carswell is a precipitous, dome-shaped island, with an area of 17.4 ha, and a maximum elevation of about 80 m. The only walking access to the top of the island is provided by the ridge that runs up from the northeast end. There is a knob at the shore end of this ridge, separated from the ridge by a low wet area. The rest of the perimeter is faced with high cliffs.

The forest is primarily spruce mixed with hemlock in higher areas. Much of it is fairly young (30 cm dbh), with some large, older spruce scattered through it. Mossy deadfall or windfall is abundant. Patches of small, regenerating spruce occur throughout. Steep perimeter slopes are grassy, with moss and bare litter in interior areas. Short salal (Gaultheria shallon) (35 cm high) covers most of the low knob at the northeast end.

Nesting species:

Storm-petrel: Storm-petrel burrows occurred on the northeast knob, and extended up the ridge on the steep grassy slopes, where they were mixed with the more abundant Cassin's Auklets (Figure WM050-1). Most were within 7 m of the vegetation edge on the north part of the knob, and within 30 m of the edge of the vegetation on the ridge for a total area of approximately 0.7 ha. Burrows were located under roots and along deadfall in open areas and under the edges of young spruce.

From partial counts, we estimated a total of 290 burrows, which we would round to 300. No occupancy was determined. The nesting population was estimated to be 270 pairs.

Ancient Murrelets: Ancient Murrelets were nesting sparsely over much of the vegetated habitat (Figure WM050-1). Density was highest on steep, 50° slopes on the west side. Burrows were located mainly under tree bases, roots and logs.

From partial counts on the northeast knob and ridge, we estimated 210 burrows. Extrapolating this "density" over the rest of the island where burrowing extended, we arrived at a total estimate of 2740 burrows in an area of approximately 6.8 ha. No occupancy was determined. We estimated 1700 pairs nesting.

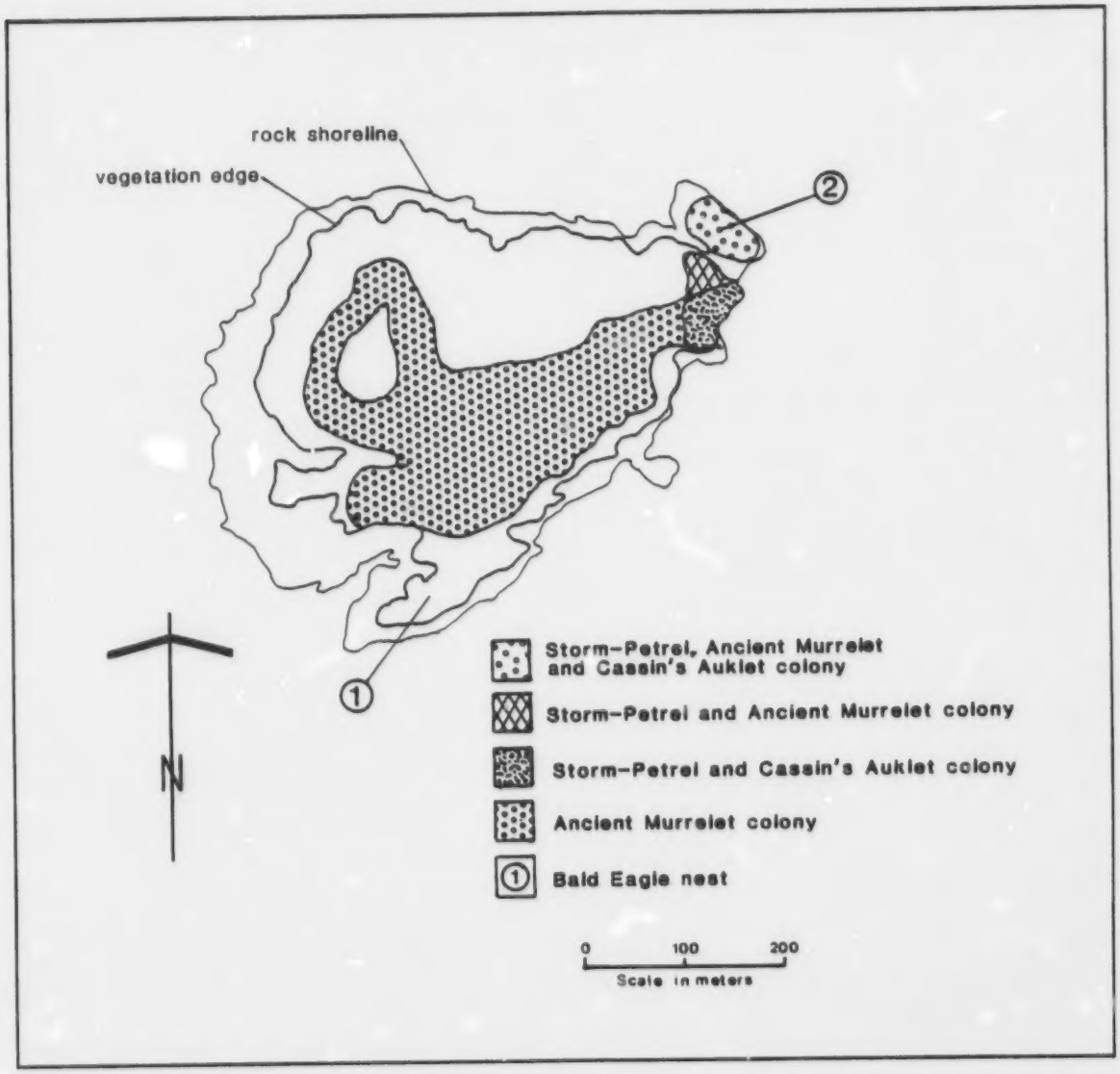


Figure WM050-1. Seabird colony areas on Carswell Island in 1986.

Cassin's Auklet: Cassin's Auklets were found nesting over approximately 0.6 ha on the perimeter of the northeast knob and ridge (Figure WM050-1). Burrowing was dense on the steep grassy slopes on the ridge. On the lower knob, burrows were scattered under the salal up to 5 m from the edge. Most burrows were around the bases of trees and along logs. There were lots of droppings and regurgitated food at burrow entrances.

From partial counts, we estimated a total of 240 burrows, and a nesting population of 180 pairs.

Rhinoceros Auklet: Rhinoceros Auklet burrows were sparsely scattered around the perimeter. We estimated a total of 30 burrows. No occupancy was determined. About 20 pairs were suspected nesting.

Predation: There were signs of predation on Ancient Murrelets (7 feather piles and 12 eggshells).

Associated species:

Bald Eagle - 2 nests:

1. On southwest corner - 20 m high in 40 m spruce. 2 adults present on 7 May.
2. On southeast end - 25 m high in 30 m spruce. 2 adults present on 7 May.

WM-070 INSTRUCTOR ISLAND 103 F/1

Location: On the north side of Inskip Channel, east of Fairlie Point. 53°01'20"N 132°19'20"W

Land status: Provincial Crown Land.

Date of survey: 18 May (exploration), 27 May 1986 (transects).

Colony access: Drop-off from boat.

Observers: M. Rodway, M. Lemon, G. Kaiser.

Census method: 23 quadrats (3x3 m) spaced 15 m apart along 5 parallel transects spaced 75 m apart and run at a bearing of 315° across the long axis of the island from shore edge to shore edge. Transects 1, 2 and 5 began on the southeast shore of the island, transects 3 and 4 began on the northwest shore (Table WM070-1, Fig. WM070-1).

Table WM070-1 Transect parameters and extent of storm-petrel, Ancient Murrelet and Rhinoceros Auklet colonies on Instructor Island in 1986.

Transect Parameters					Extent of Colonies								
					Storm-Petrel			Ancient Murrelet			Rhinoceros Auklet		
Transect	Bearing (°)	Total length (m)	Average Slope (°)	Range of Slope (°)	Dist. along transect (m)	Dist. from nearest shore Min. (m)	Dist. from nearest shore Max. (m)	Dist. along transect (m)	Dist. from nearest shore Min. (m)	Dist. from nearest shore Max. (m)	Dist. along transect (m)	Dist. from nearest shore Min. (m)	Dist. from nearest shore Max. (m)
1	315	38	12	0-25	0-38	0	19	0-38	0	19	0-38	0	19
2	315	74	16	0-35	0-74	0	26	0-74	0	26	0-74	0	26
3	135	41	4	0-5	0-41	0	20	0-41	0	20	0-41	0	20
4	135	83	12	0-45	0-83	0	42	0-83	0	42	0-8	0	8
											68-83	0	15
5	315	87	15	0-45	0-87	0	36	0-87	0	36	0-23	0	23
											67-87	0	19

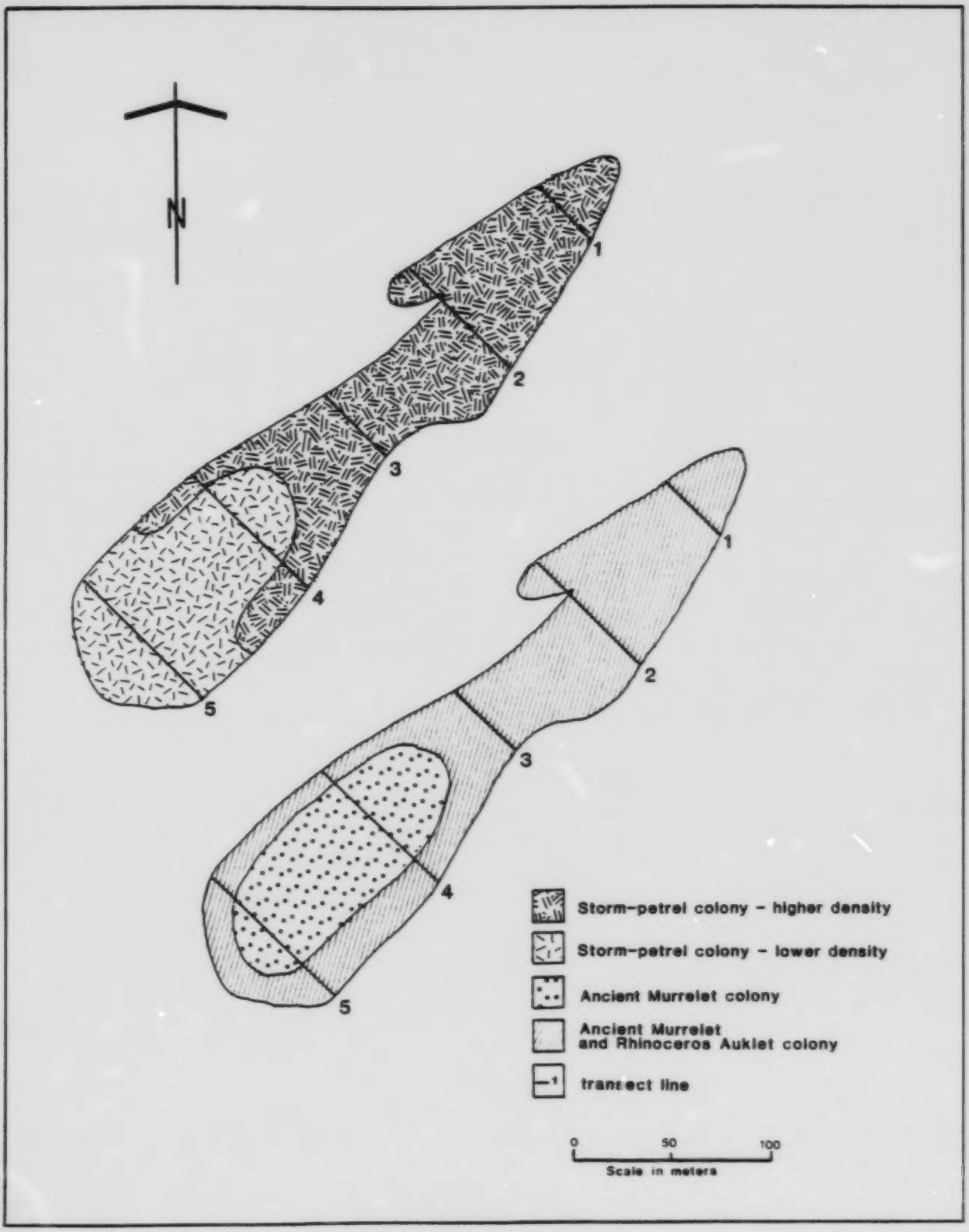


Figure WM070-1. Seabird colony areas on Instructor Island in 1986.

Description: Instructor is an undulating, oblong island, with an area of 2.3 ha. It has rocky sides, with small bluffs, and rises to about 15-20 m elevation. The vegetated area is mostly moss under a forest of spruce and hemlock. Sitka Alder occurs along the rocky edge.

Nesting species:

Storm-petrel: We found storm-petrel burrows scattered over the island primarily under tree roots and stumps, with some directly into the open ground (Table WM070-2, Fig. WM070-1). They were most abundant along the southeast side.

Table WM070-2. Habitat locations of storm-petrel, Ancient Murrelet and Rhinoceros Auklet burrow entrances on Instructor Island in 1986.

	Storm-petrel		Ancient Murrelet		Rhinoceros Auklet	
Location	Number of Burrows	Percent of Total	Number of Burrows	Percent of Total	Number of Burrows	Percent of Total
Tree base	1	6	-	-	3	30
Tree roots (live)	7	44	2	17	4	40
Stump	2	13	5	42	1	10
Tree roots (dead)	4	25	1	8	1	10
Fallen tree/log	-	-	4	33	1	10
Open ground	2	13	-	-	-	-
Total	16		12		10	

Number of sample plots: 23 (207 m^2 - 0.9% of colony)

Average Density: 770 $\pm$ 350 burrows/ha (Table WM070-3)

Colony Area: 2.3 ha

Total Burrows: 1762 $\pm$ 800.

1986 Occupancy Rate: No rate was determined. One incubating Fork-tailed Storm-Petrel was found in one burrow, and another was heard calling from another burrow. Some burrows had signs of fresh digging at the entrance. Fork-tailed Storm-Petrel feathers were found in a few burrows.

1986 Nesting Population: Using the B.C. median occupancy rate of 91%, we estimated 1603 $\pm$ 728 pairs (see Remarks).

Black Oystercatcher: One pair of oystercatchers was nesting on the rock at the northeast end. The nest of rock chips and clam shell fragments held 3 eggs on 18 May.

Pigeon Guillemot: We counted a maximum of 17 birds along the southeast side of the island on 30 May at 1000 h. There were 7 present on 18 May at 1430 h. We suspect they were nesting in crevices along the edge of the vegetation.

Ancient Murrelet: Ancient Murrelet sized burrows were sporadic over the island around tree roots, stumps and under logs (Table WM070-2). Burrow entrances were worn, but there was little other sign of occupancy. It is possible some of these burrows may have been Cassin's Auklet burrows that were not in use.

Number of sample plots: 23 (207 m^2 - 0.9% of colony)

Average Density: 530 $\pm$ 150 burrows/ha (Table WM070-4)

Colony Area: 2.3 ha

Total Burrows: 1212 $\pm$ 343.

1986 Occupancy Rate: Not determined. Three burrows explored were empty but did contain old eggshell fragments.

1986 Nesting Population: Using the median B.C. occupancy rate of 63%, we estimated 764 $\pm$ 216 pairs (see Remarks).

Rhinoceros Auklet: Most burrows on the island were Rhinoceros Auklet sized, found primarily under tree bases and roots. Burrows occurred throughout the vegetated area, but were most concentrated on the southeast side and were absent from the interior of the southwest end (Fig. WM070-1; Table WM070-1).

Number of sample plots: 16 (144 m^2 - 0.9% of colony)

Average Density: 690 $\pm$ 240 burrows/ha (Table WM070-5)

Colony Area: 1.6 ha

Total Burrows: 1101 $\pm$ 383.

1986 Occupancy Rate: The entrances to burrows were worn, but there was little other sign of active use. During the exploration, we only observed three burrows with droppings at the entrance. Eggshell fragments from the previous season were pulled from three burrows.

1986 Nesting Population: Using the median B.C. occupancy rate of 77%, we estimated 848 $\pm$ 295 pairs (see Remarks).

Table WM070-3. Number of storm-petrel burrows in 3x3 m plots along transects on Instructor Island in May 1986.

Transect	Plot number					
	1	2	3	4	5	6
1	1	0	4			
2	1	0	2	0	0	
3	0	0	1			
4	6	0	0	0	0	1
5	0	0	0	0	0	0

Table WM070-4. Number of Ancient Murrelet burrows in 3x3 m plots along transects on Instructor Island in May 1986.

Transect	Plot number					
	1	2	3	4	5	6
1	0	0	2			
2	0	0	0	0	0	
3	1	1	1			
4	0	1	1	1	0	0
5	0	0	2	0	0	1

Table WM070-5. Number of Rhinoceros Auklet burrows in 3x3 m plots along transects on Instructor Island in May 1986. Plots considered outside the colony are indicated by a dash.

Transect	Plot number					
	1	2	3	4	5	6
1	2	0	0			
2	3	0	1	0	0	
3	1	0	1			
4	1	-	-	-	-	0
5	1	0	-	-	-	0

Predation: We found no evidence of recent predation. There were four old Rhinoceros Auklet feather piles, and we recorded 21 burrows that had been dug-up, probably during the last season. River otters may have been responsible as runs were frequent on the mid-southeast side and on the east end, though no feathers were found in their scats.

Remarks: As noted above in the accounts of nesting species, we saw few signs of occupied burrows on Instructor Island. We felt that the above species were still nesting on the island, but that many of the burrows may have been unoccupied, and their populations may be declining. As we were unable to determine occupancy rates for the burrowing species, we used median B.C. rates to estimate nesting populations. This may overestimate actual numbers if populations are declining. Further investigations are required to clarify the status of nesting populations.

Associated species:

Bald Eagle - 2 adults
Marbled Murrelet - 1 off southwest end.
Northwestern Crow - 1 nest of lichens and cedar bark with 4 eggs.
Nest on ground under overhang.
1 empty nest of arboreal lichens, old wood and bark.

River Otter - The forest floor was littered with abalone shells.
Sitka deer

Other sightings:

Wandering Tattler
Rufous Hummingbird
Red-breasted Sapsucker - 1 nest hole 15 m up in an 18 m snag.
Two adults at nest.
Hairy Woodpecker - 1 nest 4 m up in 8 m spruce snag. In middle of island.
Adult flew out.
Fox Sparrow

WM-080 LIHOU ISLAND 103 F/1

Location: On the north side of Englefield Bay off the mouth of Inskip Channel.
53°00'20"N 132°25'W

Land status: Provincial Crown Land.

Date of survey: 7 May, 1130 h (Pigeon Guillemot count from boat), 8,9,10 May (exploration and transects), and 14,21,22,27 May 1986 (transects). There were usually four people at a time working on the island on these dates.

Colony access: Drop-off from boat. Lihou is a very dissected island and access to colony areas was difficult. We regularly dropped crews off in the small, pocket bay on the mid-south side, where it was feasible to climb to the higher sections to the east and west. This bay is reasonably protected except in strong southerly winds. Access to higher slopes was also possible from the north side, both at the east and west ends, and at the western end of the largest segment of the island.

Base camp: Not suitable.

Observers: M. Lemon, M. Rodway, D. Powell, D. Garnier, A. Eisenhawer, D. Grinnell, H. Hay.

Census method: When we first began transecting the colony we surveyed 34 quadrats (7x7 m) at 30 m intervals along 3 parallel transects spaced 200 m apart. These plots were too large for the density of burrows, so plot size was decreased along the remaining 11 transects. These were laid out 100 m apart, with 71 quadrats (5x5 m) surveyed at 30 m intervals. Transects were run due north and south either side of a line chained down the centre of the island. They extended as far towards shore as we could safely access (Table WM080-1, Fig. WM080-1). Plots were then renumbered beginning on one shore of the island and extending to the opposite side. Remaining ground distance to the edge of the vegetation was estimated or measured from the airphoto.

Description: Lihou is a rugged, precipitous, deeply dissected island, which was difficult to land on, and difficult to traverse. It is divided into four segments by deep gorges, cliffs, and low saddles. There are two large sections in the middle, with smaller sections at either end (Figure WM080-1). The total area of the island is 75 ha. The majority of the perimeter is cliff, rock bluff, or very steep vegetated slopes. Cliffs are higher on the south side, and the steep slopes rise to a maximum elevation of 120 m on the western of the two large segments. Alternating steep ridges and valleys run perpendicular to the shore all around the island. Interior areas are more gently undulating. There are large sea-caves on both the north and south sides, and a small pocket bay on the south side.

Spruce (mostly 0.6 m - 0.8 m dbh) is the dominant tree over extensive areas on the steep perimeter slopes, and over most of the east and west sections. Slopes under mature spruce are mostly grassy, primarily Calamagrostis, mixed with Heracleum lanatum, and patches of moss and Maianthemum dilatatum. On the two larger middle sections, moss and bare litter occur in interior areas of mature forest where hemlock (mostly 0.4 m - 0.7 m dbh) and redcedar mix with spruce. Sitka Alder grows along the tops of cliffs and on steep, wet grassy slopes, especially on the north side. Currant (Ribes sp.), salmonberry (Rubus spectabilis) and elderberry (Sambucus racemosa) also occur on these wet slopes. Large sections of the island are covered with regenerating spruce of various ages. Throughout these areas are old spruce monarchs 1.5-1.8 m dbh. Much of the higher, southern slopes of the middle sections are covered with 10-20 m tall spruce, with smaller, 3-5 m tall thickets occurring on the edges above grassy slopes. Abundant, old deadfall or windfall congest the forest floor in these areas. Patches of young spruce (2-10 m high) occur over the centre of the west section, and along the north side of the island.

Table WM080-1 Transect parameters on Lihou Island in 1986.

Tran.	Bearing (°)	Tran. length (m)	Width of vegetation across island (m)	Distance to vegetation edge		Elevation of transect			Average slope (°)	Range of slope (°)
				From tran.beg. (m)	From tran.end. (m)	Beg. (m)	End (m)	Max. (m)		
1	360	37		0		55	60	60	20	10-30
2	360	68	160	26	66	60	45	60	37	20-45
3	360	275	387	12	100	30	75	100	31	2-70
4	360	457	510	3	50	25	64	111	22	0-37
5	360	247	333	40	46	41	51	90	27	7-43
6	360	335	335	0	0	10	30	100	36	24-55
7	180	245	245	0	0	70	10	70	32	10-60
8	360	335	335	0	0	20	58	100	23	0-50
9	180	335	362	12	15	70	15	120	36	10-75
10	180	155	230	15	60	80	110	110	31	20-40
11	180	58	72	14	0	80	60	80	26	15-45
12	360	125	150	5	20	5	45	55	34	25-45
13	180	109	134	25	0	30	35	47	19	1-33
14	180	106	106	0	0	30	10	30	17	5-30

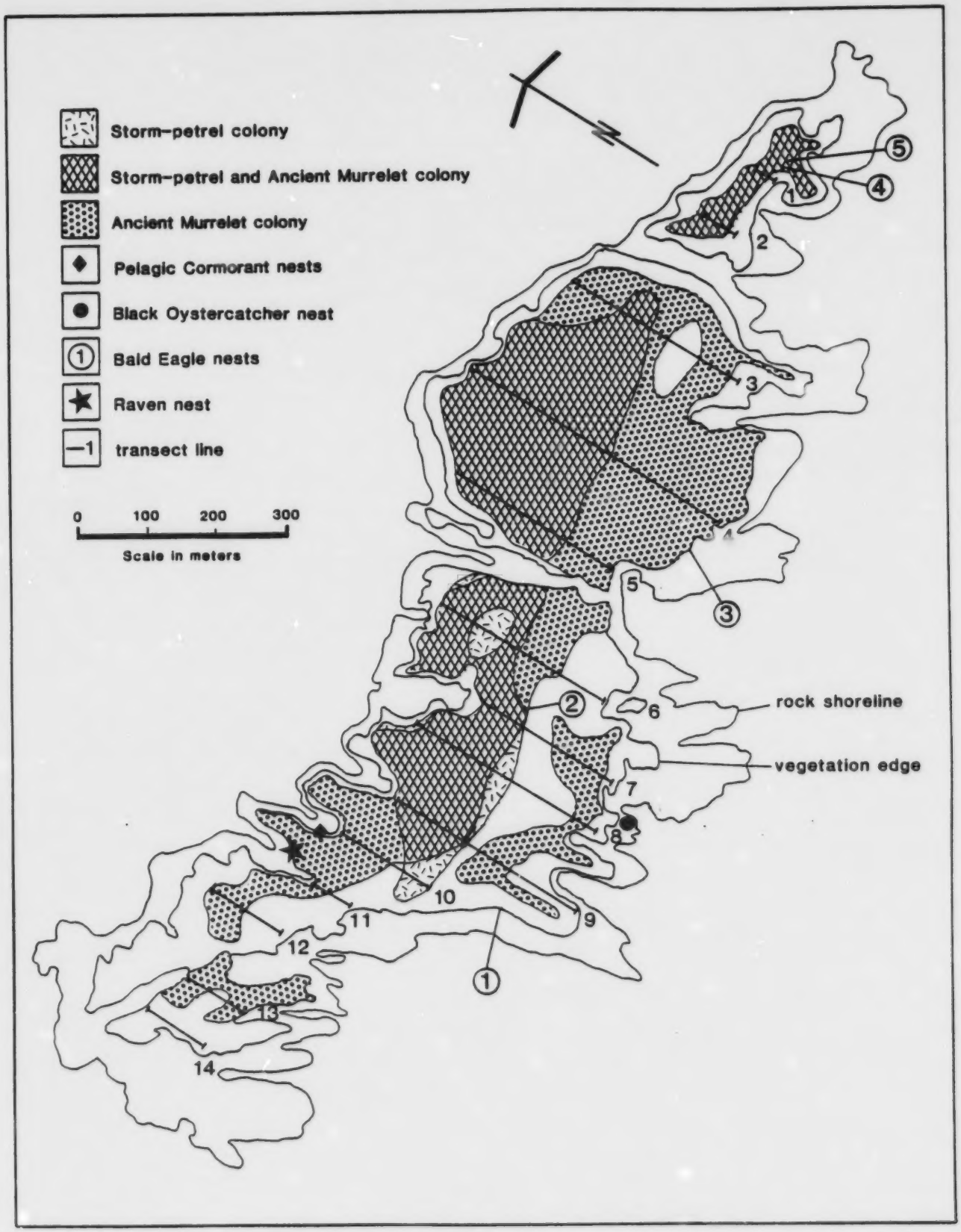


Figure WM080-1. Storm-petrel and Ancient Murrelet colony areas and transect locations on Lihou Island in 1986.

Nesting species:

Storm-petrel: The storm-petrel colony on Lihou is unusual in that they are nesting in conjunction with Ancient Murrelets in the interior of a large island. We have typically found them on small islands, or only on the perimeter of larger islands. On Lihou, petrels were nesting over most of the higher, northern slopes on the two middle sections, and on the east section (Figure WM080-1). We found them in grass, under regenerating spruce, and in mossy or bare litter interior areas as far as 200 m from shore and 114 m in elevation (Table WM080-2). They occurred on slopes of 5 to 55° (average = 25°). Burrow entrances were located under roots, tree bases, fallen logs and in open ground (Table WM080-3).

Number of sample plots:

East section:	3 (75 m^2 - 0.6% of colony)
East middle section:	17 (833 m^2 - 1.0% of colony)
West middle section:	22 (550 m^2 - 0.8% of colony)
Total:	42 (1458 m^2 - 0.9% of colony)

Average Density:

East section:	133 $\pm$ 133 burrows/ha
East middle section:	924 $\pm$ 217 burrows/ha
West middle section:	1109 $\pm$ 348 burrows/ha (Table WM080-4)
Overall:	938 $\pm$ 183 burrows/ha

Colony Area:

East section:	1.3 ha
East middle section:	7.9 ha
West middle section:	6.8 ha
Total:	16.0 ha

Total Burrows:

East section:	169 $\pm$ 169
East middle section:	7,272 $\pm$ 1,708
West middle section:	7,570 $\pm$ 2,375
Total:	15,011 $\pm$ 2,930

1986 Occupancy Rate: We were too early in the season to determine occupancy. Six burrows we reached the ends of were empty but many burrows had fresh hemlock twigs and lichens pulled into the entrances and tunnels. Piles of loose fresh earth at the entrances to the burrows also indicated recent activity on the colony. We heard both Fork-tailed and Leach's storm-petrels in burrows.

1986 Nesting Population: Using the median B.C. occupancy rate of 91%, we estimated 13,660 $\pm$ 2666 pairs of both species nesting.

Table WM080-2 Extent of storm-petrel and Ancient Murrelet colonies on Lihou Island in 1986. "+" indicates the colony extended into an inaccessible slope beyond the end of the transect.

	Storm-petrel					Ancient Murrelet				
Transect	Dist. along transect (m)	Dist. from nearest vegetation edge Min. (m)	Max. (m)	Range of elevation along tran. (m)	Average slope along tran. (°)	Dist. along transect (m)	Dist. from nearest vegetation edge Min. (m)	Max. (m)	Range of elevation along tran. (m)	Average slope along tran. (°)
1	15-37	15	37	55-60	10	15-37	15	37	55-60	10
2	15-68	41	50	45-60	32	15-68	41	50	45-60	32
3	165-225	110	120	95-100	25	15-75	27	87	41-72	32
						135-275+	90	120	40-100	34
4	195-457	50	200	64-111	21	0-457	0	200	25-111	22
5	75-247	0	70	51-90	24	0-247	0	70	41-90	27
6	135-335	0	120	30-100	38	90-195	90	120	35-93	33
						255-335	0	80	30-81	45
7	0-75	0	75	63-70	23	0-75	0	75	63-70	23
						135-225	15	105	12-40	33
8	165-335	0	120	58-98	16	15-45	5	20	30-48	30
						195-315	15	120	63-93	9
9	0-105	15	117	70-117	25	0-105	0	117	70-117	25
						135-195	30	90	82-115	30
10	105-155	60	80	110	35	0-75	0	80	80-110	31
11	-					0-15	0	29	75-80	18
12	-					75-125	40	80	45-55	30
13	-					0-45	25	55	30-45	25
						75-109	0	34	35-40	24
14	-					-				

Table WM080-3. Habitat locations of storm-petrel, Ancient Murrelet, Cassin's Auklet and Rhinoceros Auklet burrow entrances on Lihou Island in 1986.

	Storm-petrel		Ancient Murrelet		Cassin's Auklet		Rhinoceros Auklet	
Location	Number of burrows	% of Total	Number of burrows	% of Total	Number of burrows	% of Total	Number of burrows	% of Total
Tree base	16	11	10	11	5	5	2	8
Tree roots (live)	32	23	25	28	27	30	5	20
Stump	9	6	13	14	4	4	2	8
Tree roots (dead)	14	10	9	10	3	3	4	16
Fallen tree/log	49	35	25	28	25	27	5	20
Rock	-	-	-	-	4	4	-	-
Grass tussock	1	1	-	-	9	10	1	4
Open ground	10	7	1	1	1	1	-	-
Into bank	9	6	7	8	13	14	6	24
Total	140		90		91		25	

Table WM080-4. Number of storm-petrel burrows in 5x5 m plots (Transects 1, 2, 6-14) and 7x7 m plots (Transects 3-5) along transects on Lihou Island in 1986. Plots considered outside the colony are indicated by a dash.

Plot	Transect													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	-	-	-	-	-	-	2	-	3	-	-	-	-	-
2	0	1	-	-	-	-	13	-	0	-	-	-	-	-
3		0	-	-	-	-	0	-	0	-		-	-	-
4			-	-	9	-	-	-	6	-		-	-	-
5			-	-	1	-	-	-	-	0		-		
6			-	-	0	0	-	-	-	2				
7			2	-	13	1	-	0	-					
8			4	1	3	4	-	3	-					
9			-	1	1	14	-	9	-					
10			-	11		0		0	-					
11				6		0		1	-					
12				10		0		5	-					
13				6										
14				9										
15				0										
16				0										

Pelagic Cormorant: We counted 24 cormorant nests in the east entrance to the large sea-arch on the mid-north side. No cormorants were present on any of our visits. We found 5 eggshells below the nests, that we suspected were from last season. Perhaps the nests were attended later in the 1986 season.

Black Oystercatcher: On 21 May, we found 1 nest with 3 eggs on the mid-south side near the sea-arch. The nest was on a small grassy patch on the rock. A pair of oystercatchers was repeatedly seen on the mid-north shore.

Pigeon Guillemot: On 7 May at 1130 h, we counted a total of 80 Pigeon Guillemots around the shore rocks. Most were around the west end and the north side at the east end, where we saw birds flying out of crevices and from under the edge of the vegetation.

Ancient Murrelet: Ancient Murrelets were nesting over much of the higher portions of the island (Figure WM080-1). Burrows occurred near shore, but were most abundant in interior areas (Tables WM080-2, and WM080-5). They were located in grass, under spruce regeneration, and in moss or bare litter under mature forest. Burrow entrances were under roots, tree bases, logs and stumps (Table WM080-3), on slopes of 5 to 55° (average = 27°). They were absent from extensive tracts of thick, young spruce, and from wet grassy slopes.

Table WM080-5. Number of Ancient Murrelet burrows in 5x5 m plots (Transects 1, 2, 6-14) and 7x7 m plots (Transects 3-5) along transects on Lihou Island in 1986. Plots considered outside the colony are indicated by a dash.

Plot	Transect													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	-	-	-	3	0	-	0	-	0	0	3	-	1	-
2	1	1	0	1	1	-	0	0	0	1	-	-	0	-
3		1	4	0	2	-	0	-	0	1		-	-	-
4			-	2	4	0	-	-	0	-		0	1	-
5			-	6	0	2	-	-	-	-		0		
6			2	4	0	1	2	-	2	-				
7			5	5	0	0	0	-	0					
8			0	7	3	-	0	1	-					
9			1	0	4	-	-	1	-					
10			3	1		0		0	-					
11				4		0		0	-					
12				2		0		-	-					
13				3										
14				4										
15				0										
16				0										

Number of sample plots:

East section:	3 (75 m^2 - 0.6% of colony)
East middle section:	32 (1568 m^2 - 1.0% of colony)
West sections:	33 (825 m^2 - 0.6% of colony)
Total:	68 (2468 m^2 - 0.8% of colony)

Average Density:

East section:	400 $\pm$ 0 burrows/ha
East middle section:	453 $\pm$ 74 burrows/ha
West sections:	194 $\pm$ 55 burrows/ha
Overall:	338 $\pm$ 45 burrows/ha

Colony Area:

East section:	1.3 ha
East middle section:	16.0 ha
West sections:	13.0 ha
Total:	30.3 ha

Total Burrows:

East section:	509 $\pm$ 0
East middle section:	7,217 $\pm$ 1,179
West sections:	2,516 $\pm$ 713
Total:	10,242 $\pm$ 1378

1986 Occupancy Rate: We determined the contents of 7 burrows: 3 held adults incubating 2 eggs, 1 contained 2 cold eggs, and 3 were empty. This sample was too small to calculate a rate.

1986 Nesting Population: Using the median B.C. occupancy of 63%, we estimated 6452 $\pm$ 868 pairs.

Staging: We regularly observed small numbers of Ancient Murrelets around all sides of the island at various times of day. There were 60 off the southwest corner at 2030 h on 14 May. We sighted 800 gathered in a line extending north of Bone Point at 0900 h on 30 May. We do not know if those birds were associated with the Lihou Island colony.

Cassin's Auklet: Cassin's Auklets were nesting around much of the perimeter. They were most abundant and consistent along the southern slopes, with only scattered pockets occurring along the north side (Figure WM080-2). Burrows extended from near shore in some areas to as far as 120 m inland (although most of the colony was within 80 m of shore), and from 5 m to 100 m in elevation (Table WM080-6). They were located in grass, in mossy or bare litter ground under roots, logs, grass tussocks and into the open bank (Table WM080-3) and as far as 30 m under 2-4 m high spruce regeneration. Slopes ranged from 2 to 60° (average = 33°).

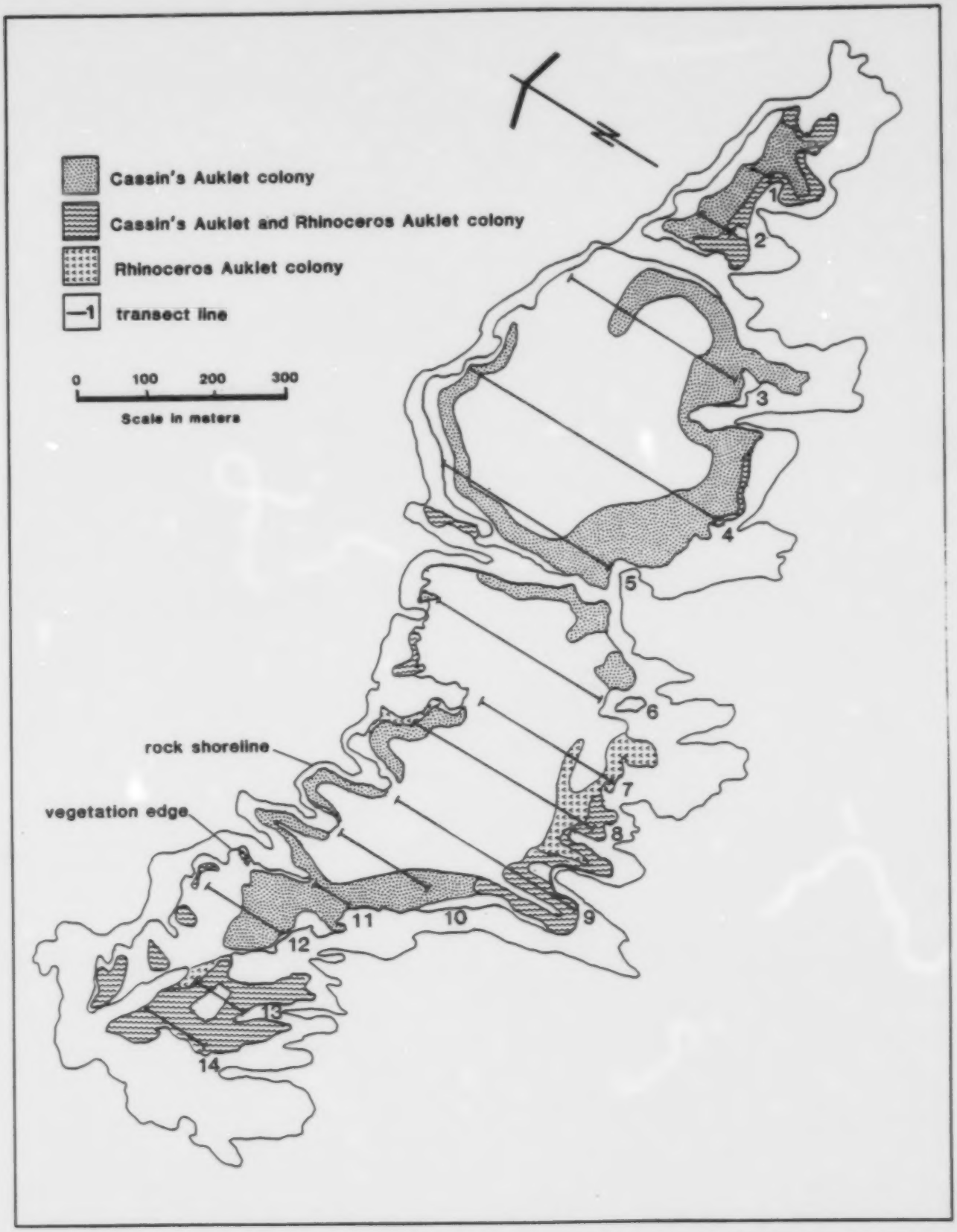


Figure WM080-2. Cassin's Auklet and Rhinoceros Auklet colony areas and transect locations on Lihou Island in 1986.

Table WM080-6 Extent of Cassin's Auklet and Rhinoceros Auklet colonies on Lihou Island in 1986. "*" indicates that the colony began at the vegetation edge, beyond the transect beginning.

	Cassin's Auklet					Rhinoceros Auklet				
Transect	Dist. along transect (m)	Dist. from nearest vegetation edge Min. (m)	Max. (m)	Range of elevation along tran. (m)	Average slope along tran. (°)	Dist. along tran. (m)	Dist. from nearest vegetation edge Min. (m)	Max. (m)	Range of elevation along tran. (m)	Average slope along tran. (°)
1	0-37	0	37	55-60	20	0-15	0	15	55	30
2	0-68	0*	50	-60	37	0-15	0	41	60	45
3	0-75	0*	87	30-72	45	-				
	195-225	110	120	95-100	25					
4	0-75	0	78	25-63	29	0-5	0	8	25	32
	435-457	50	75	60-70	37					
5	0-75	0	70	41-75	32	-				
6	-					-				
7	-					165-195	45	75	22-33	35
						225-245	0	20	10	40
8	0-15	0	5	20-30	50	0-75	0	45	20-60	38
	305-335	0	25	58-68	40					
9	195-335	0	30	15-82	51	195-335	0	30	15-82	51
10	105-155	30	77	110	32	-				
11	0-58	0	38	60-80	26	-				
12	0-75	5	80	5-55	38	-				
13	15-45	40	55	30-42	18	0-45	25	55	30-45	25
	75-109	0	34	35-40	24	75-109	0	34	35-40	24
14	0-106	0	15	10-30	17	0-106	0	15	10-30	17

Number of sample plots:

East section:	5 (125 m^2 - 0.5% of colony)
East middle section:	10 (490 m^2 - 0.7% of colony)
West sections:	19 (475 m^2 - 0.5% of colony)
Total:	34 (1090 m^2 - 0.6% of colony)

Average Density:

East section:	720 $\pm$ 445 burrows/ha
East middle section:	816 $\pm$ 319 burrows/ha
West sections:	884 $\pm$ 262 burrows/ha (Table WM080-7)
Overall:	837 $\pm$ 186 burrows/ha

Colony Area:

East section:	2.5 ha
East middle section:	6.8 ha
West sections:	8.6 ha
Total:	17.9 ha

Total Burrows:

East section:	1,810 $\pm$ 1,118
East middle section:	5,540 $\pm$ 2,166
West sections:	7,637 $\pm$ 2,263
Total:	14,987 $\pm$ 3,326

1986 Occupancy Rate: We only reached the ends of 3 burrows: two contained adults incubating 1 egg; in the third we only reached the adult. Regurgitated food was abundant at the entrances to many burrows, which indicated that many chicks had hatched at the time of our survey.

1986 Nesting Population: We estimated 11,240 $\pm$ 2495 pairs nesting (using the median B.C. occupancy rate of 75%).

Rhinoceros Auklet: We found Rhinoceros Auklets nesting in discrete patches around the perimeter (Fig. WM080-2). Greatest concentrations occurred on the south side of the western, middle section, and on the west and east ends. Small, isolated pockets were scattered on drier knobs and ridges near shore or at the top edges of cliffs along the north side. Burrows were primarily on grassy or mossy slopes above the precipitous shore. They extended as far as 45 m into thickets of young spruce. Burrows ranged from 10 m to 82 m in elevation, and as far as 75 m from shore (although the majority of the colony was within 45 m of the shore), on slopes of 5 to 60° (average = 34°) (Table WM080-6). Burrow entrances were located under tree roots and bases, logs and stumps and into the open slope (Table WM080-3).

Table WM080-7. Number of Cassin's Auklet burrows in 5x5 m plots (Transects 1, 2, 6-14) and 7x7 m plots (Transects 3-5) along transects on Lihou Island in 1986. Plots considered outside the colony are indicated by a dash. Plots marked with a star are within the colony but not surveyed.

Plot	Transect													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	6	0	*	14	0	-	-	0	-	-	0	1	-	1
2	1	2	1	4	0	-	-	-	-	-	5	5	0	0
3		0	1	1	1	-	-	-	-	-		3	-	0
4			-	-	-	-	-	-	-	-		-	4	1
5			-	-	-	-	-	-	-	0		-		
6			-	-	-	-	-	-	-	7				
7			-	-	-	-	-	-	-					
8			10	-	-	-	-	-	*					
9			-	-	-	-	-	-	0					
10			-	-	*	-		-	8					
11				-	*	-		-	0					
12				-	*	-		7	0					
13				-										
14				-										
15				-										
16				8										

Number of sample plots: 19 (499 m^2 - 0.7% of colony)

Average Density: 505 ± 170 burrows/ha (Table WM080-8)

Colony Area:

East section:	1.2 ha
East middle section:	0.2 ha
West sections:	5.6 ha
Total:	7.1 ha

Total Burrows:

East section:	627 ± 211
East middle section:	103 ± 35
West sections:	2,835 ± 954
Total:	3,565 ± 1200

Table WM080-8. Number of Rhinoceros Auklet burrows in 5x5 m plots (Transects 1, 2, 6-14) and 7x7 m plots (Transects 3-5) along transects on Lihou Island in 1986. Plots considered outside the colony are indicated by a dash. Plot marked with a star is within the colony but not surveyed.

Plot	Transect													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	2	0	-	0	-	-	-	1	-	-	-	-	1	3
2	-	-	-	-	-	-	-	0	-	-	-	-	0	1
3		-	-	-	-	-	-	4	-	-	-	-	-	0
4			-	-	-	-	-	-	-	-		-	3	0
5			-	-	-	-	-	-	-	-		-		
6			-	-	-	-	-	-	-	-				
7			-	-	-	-	1	-	-					
8			-	-	-	-	-	-	*					
9			-	-	-	-	0	-	0					
10			-	-		-		-	7					
11				-		-		-	0					
12				-		-		-	1					
13				-										
14				-										
15				-										
16				-										

1986 Occupancy Rate: We determined the contents of 2 burrows: 1 held an incubating adult, and 1 contained an addled egg with a partially formed embryo (last year's).

1986 Nesting Population: We estimated 2745 ± 924 pairs nesting (using the median B.C. occupancy rate of 77%).

Staging: We encountered small numbers of Rhinoceros Auklets on the water around the island at various times of day. The maximum observed was 70 in a feeding assemblage off the east end at 1040 h on 22 May.

Tufted Puffin: Puffins were suspected nesting on the precipitous grassy bluffs on the southwest point of the western middle section. We counted a maximum of 27 birds on the water around this area at 1830 h on 8 May. There were 9 puffins present here at 2030 h on 14 May.

Predation: Evidence of predation was not abundant on Lihou. On our exploration we found remains of Ancient Murrelets (12 feather piles, 2 single wings, 1 pair of attached wings that a raven had been feeding on, and 11 eggshells), Fork-tailed Storm-Petrels (3 feather piles), Leach's Storm-Petrels (1 skeleton), and Cassin's Auklets (2 feather piles and 3 wings). In the surveyed plots only depredated remains of Ancient Murrelets were found (Table WM080-9). Within the 68 surveyed plots 6 feather piles were recorded. This gives a mean density of 30 ± 11 feather piles/ha. Extrapolating this over the 30.3 hectares of Ancient Murrelet colony yields 910 ± 327 depredated birds at the time of our survey.

We also found a Parakeet Auklet bill in an old eagle pellet, and a Sooty Shearwater and Northern Fulmar skull in the same area.

Table WM080-9. Depredated remains of Ancient Murrelets in plots along transects on Lihou Island in 1986. Plots along transects 1,2,6-14 are 5x5 m and plots along transects 3-5 are 7x7 m.

Tran.	Plot	Date	Feather pile	Single wing	Pair of wings	Carcass	Depredated egg	Bald Eagle pellet
1	2	22 May	1					
2	2	22 May	1					
4	2	10 May					1	
4	4	10 May		1				
4	7	9 May				1		
4	10	9 May	1					
4	11	9 May						1
7	6	27 May	1					
9	2	21 May			1			
9	3	21 May	1		1			
9	6	21 May	1			1		
9	10	21 May						1
10	3	14 May			1			

Associated species:

Bald Eagle - We saw a maximum of 7 immatures and 3 adults together on the south shore on 21 May. We found 5 nests (see Figure WM080-1):

1. Towards the west end of the west middle section - 20 m high in 25 m spruce at 100 m elevation. 2 adults present on 14 May.

2. South side of the west middle section, just east of transect 7 - 25 m high in 50 m, 2.0 m dbh spruce at about 100 m elevation. Nest is a 1.5 m high platform of sticks with currant growing around the rim. Nest is on a large limb, 2 m from the trunk.

3. On east side of main mid-south bay - 25 m high in 40 m spruce on the edge of the shore rock of a small headland. On May 10 at least 2 eggs were seen in the nest and an adult was present at the nest turning the eggs.

4. East end - 25 m high in 35 m spruce on edge of cliff above most eastern chute on north side. One adult present on 8 & 22 May.

5. Just east of #4 - dilapidated nest 25 m high in 35 m spruce on ridge top.

Peregrine Falcon

Northwestern Crow - We found 3 nests: 2 with 3 young, and 1 with 2 young.

Common Raven - 1 nest on the cliff above the west entrance to the large sea-arch on the mid-north side. The nest, composed of a large pile of sticks with a grass lining, was on a ledge about 20 m below the forest edge. One young in the nest and the remains of a second at the base of the cliff on 8 May.

River Otter - dens and trails
Hair Seal - 49 hauled out on the west rocks below the west end on 22 May.
Elephant Seal - 1 found washed up on the rocks on the south side.
Sitka deer - trails and pellets.

Other sightings:

Rufous Hummingbird - 8 May.
Western Flycatcher
Winter Wren
Swainson's Thrush - Singing 22 May.
Orange-crowned Warbler
Townsend's Warbler

WM-090 BONE POINT 103 F/1

Location: On the northwest tip of Hibben Island. 53°00'18"N 132°23'06"W

Land status: Provincial Crown Land.

Date of survey: 15 May 1200 h, 25 May 1630 h, and 30 May 0905 h (observations from boat), and 18 May 1986, 1140-1320 h (exploration of vegetated area).

Colony access: Drop-off from boat.

Observers: M. Rodway (exploration), M. Lemon, D. Powell, D. Grinnell (from boat).

Census method: Exploration.

Description: Bone Point has precipitous sides with a number of jagged rock pinnacles on the outer west tip. Cliffs are higher on the north side of the point, and the slopes on the top generally tend south. The 8.0 ha point is separated from the main part of Hibben Island by a narrow, cliff bound channel. Most of the area is covered with grass (Calamagrostis) mixed with moss, under an open spruce forest (0.6-1.0 m dbh). Thick, young spruce and hemlock (2-10 m tall) grow over most of the upper slopes to the north. There had been a few windfalls on the northeast corner.

Nesting species: There was no sign of burrowing in the vegetated habitat.

Black Oystercatcher: We observed one pair on the west rocks on 18 May.

Glaucous-winged Gull: We counted 19 adults on territory on 15 May, and 35 on 18 May. We estimated 15-20 pairs nesting.

Pigeon Guillemot: We counted a maximum of 29 birds around the west rocks on 15 May.

Tufted Puffin: There were a maximum of 12 puffins on 15 May. They were on the water and flying around the nose of the ridge below the northwest corner of the treed area. We saw 6 on the 18 May, and 8 on 30 May. No puffins were sighted on 25 May.

Associated species:

Pelagic Cormorant - 1 adult, 1 immature on 15 May.

Glaucous-winged Gull - 15 immatures on 15 May, and 28 on 18 May.

Other sightings:

Herring/Thayer's Gull - 1 adult, 3 immature roosting on 15 May.

WM-100 LUXMOORE ISLAND 103 C/16

Location: Englefield Bay, northwest of Cape Kuper on the southwest corner of Hibben Island. 52°58'40"N 132°21'W

Land status: Provincial Crown Land.

Date of survey: 15 May, 1430-1700 h (exploration), 28 May 1986 (transects).

Colony access: Drop-off from boat.

Observers: M. Lemon, D. Powell, D. Grinnell.

Census method: 24 quadrats (3x3 m) spaced 15 m apart along 4 parallel transects spaced 75 m apart and run at a bearing of 360° (Table WM100-1). Transect 4 was not surveyed across the whole width of the island due to lack of time.

Table WM100-1. Transect parameters on Luxmoore Island in 1986.

Transect	Bearing (°)	Total length (m)	Elevation			Average slope (°)	Range of slopes (°)
			Beg. (m)	End (m)	Max. (m)		
1	360	89	10	7	25	26	15-40
2	360	105	12	36	41	26	5-45
3	180	108	40	18	50	26	0-50
4	360	48	15	25	25	34	25-45

Description: Luxmoore has an abrupt, dissected shoreline and a rounded interior. One crevice cuts right through the island, creating a narrow, precipitous saddle bridging the east and west sections. There is an expansive rocky area at the west end. The island has a total area of 9.4 ha, with 3.7 ha of vegetated habitat. It rises to a maximum elevation of 50 m. The north side of the island drops abruptly from 40 m high cliffs to the rock shoreline below.

The forest is predominantly spruce of 0.6-0.9 m dbh, with extensive perimeter areas of small, regenerating spruce (2-3 m high), especially on the northeast side, where there are a number of large spruce snags. Interior areas in mature forest have a mossy understory. On the north side of the larger section, west of the landbridge, the open, mossy habitat extends to the edge of the cliffs. Most of the rest of the perimeter has a steep, grassy fringe. There are scattered young spruce (5-8 m tall) under the mature trees on the western section.

Nesting species:

Storm-petrel: Storm-petrels were nesting in almost all vegetated habitat, except on a few small, steep, grassy slopes on the edge (Figure WM100-1, Table WM100-2). Burrows were located under roots, logs, and in the open slope under spruce thickets (Table WM100-3). Density was highest on the eastern section of the island (Table WM100-4). Burrows were sparser on the grassy fringe of the island and became dense where the grass fringe met the forest edge.

Number of sample plots: 24 (216 m^2 - 0.6% of colony)

Average Density: 1708 $\pm$ 519 burrows/ha

Colony Area: 3.7 ha

Total Burrows: 6245 $\pm$ 1898

1986 Occupancy Rate: No occupancy rate was determined. We found evidence of both Fork-tailed and Leach's storm-petrels (see Predation below), but were unable to determine in what ratio they were present.

1986 Nesting Population: Using the B.C. median occupancy rate of 91%, we estimated 5683 $\pm$ 1727 pairs of storm-petrels nesting.

Pigeon Guillemot: There were 2 Pigeon Guillemots along the north side of the island on 15 May.

Ancient Murrelet: Ancient Murrelets were burrowing over most of the vegetated area, except for perimeter slopes on the south and west side (Fig. WM100-1, Table WM100-5). Burrows were located under stumps, tree roots and logs, on slopes of 5 to 50° (average = 25°) (Table WM100-2).

Number of sample plots: 17 (153 m^2 - 0.5% of colony)

Average Density: 518 $\pm$ 137 burrows/ha

Colony Area: 3.1 ha

Total Burrows: 1606 $\pm$ 425

1986 Occupancy Rate: No occupancy rate was determined.

1986 Nesting Population: 1012 $\pm$ 268 pairs estimated (with the median B.C. occupancy rate of 63%).

Cassin's Auklet: We found Cassin's Auklet burrows along the southern perimeter of the island, mostly within 30 m of the edge of the vegetation (Fig. WM100-1, Table WM100-6). Burrows were located in the open slope and under tree roots on slopes of 5 to 50° (average = 33°).

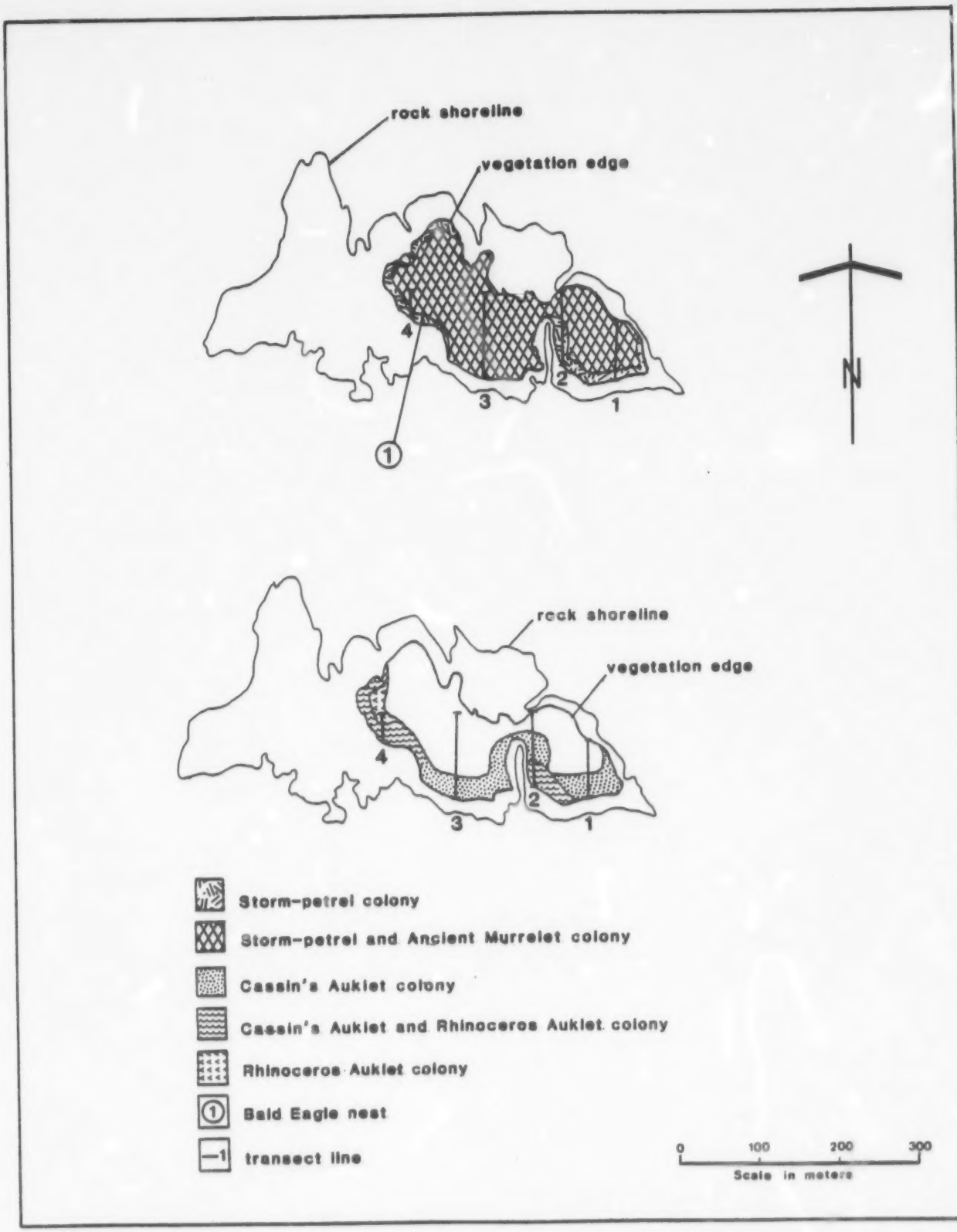


Figure WM100-1. Seabird colony areas and transect locations on Luxmoore Island in 1986.

Table WM100-2 Extent of storm-petrel, Ancient Murrelet, Cassin's Auklet and Rhinoceros Auklet colonies on Luxmoore Island in 1986.

Transect	Storm-petrel					Ancient Murrelet				
	Dist. along transect (m)	Dist. from nearest vegetation edge Min. (m)	Max. (m)	Range of elevation (m)	Average slope (°)	Dist. along transect (m)	Dist. from nearest vegetation edge Min. (m)	Max. (m)	Range of elevation (m)	Average slope (°)
1	0-89	0	45	7-25	26	7-89	7	45	10-25	25
2	0-105	0	30	12-41	26	67-105	0	23	36-41	13
3	0-108	0	48	18-50	26	0-108	0	48	18-50	26
4	0-48+	0	48	15-25	34	7-48+	7	48	18-25	35

+ colony continues, but transect not completed.

Transect	Cassin's Auklet					Rhinoceros Auklet				
	Dist. along transect (m)	Dist. from nearest vegetation edge Min. (m)	Max. (m)	Range of elevation (m)	Average slope (°)	Dist. along transect (m)	Dist. from nearest vegetation edge Min. (m)	Max. (m)	Range of elevation (m)	Average slope (°)
1	0-37	0	37	10-22	23	-				
2	0-82	0	30	12-41	28	0-37	0	15	12-30	32
3	93-108	0	15	18-23	50	-				
4	0-30	0	30	15-23	30	0-48	0	48	15-25	34

Table WM100-3. Habitat locations of storm-petrel, Ancient Murrelet, Cassin's Auklet and Rhinoceros Auklet burrow entrances in plots along transects on Luxmoore Island in 1986.

	Storm-petrel		Ancient Murrelet		Cassin's Auklet	Rhinoceros Auklet
Location	Number of burrows	% of Total	Number of burrows	% of Total	Number of burrows	Number of burrows
Fallen tree/log	17	46	1	13		1
Into bank	16	43	1	13	2	
Live tree roots	2	5	1	13	1	3
Dead tree roots	2	5	1	13		
Under stump			3	37		
Under rock			1	13	1	
Total	37		8		4	4

Table WM100-4. Number of storm-petrel burrows in 3x3 m plots along transects on Luxmoore Island in 1986.

Transect	Plot number						
	1	2	3	4	5	6	7
1	0	6	6	1	1	0	
2	2	4	0	8	1	2	0
3	1	0	0	0	0	0	0
4	0	3	2	0			

Table WM100-5. Number of Ancient Murrelet burrows in 3x3 m plots along transects on Luxmoore Island in 1986. Plots considered outside the colony are indicated by a dash.

Transect	Plot number						
	1	2	3	4	5	6	7
1	-	1	1	0	1	0	
2	-	-	-	-	-	0	1
3	0	0	0	0	1	1	1
4	-	1	0	0			

Table WM100-6. Number of Cassin's Auklet burrows in 3x3 m plots along transects on Luxmoore Island in 1986. Plots considered outside the colony are indicated by a dash.

Transect	Plot number						
	1	2	3	4	5	6	7
1	1	1	0	-	-	-	
2	1	0	0	1	0	0	-
3	-	-	-	-	-	-	-
4	0	0	-	-			

Number of sample plots: 11 (99 m^2 - 0.8% of colony)

Average Density: 400 ± 167 burrows/ha

Colony Area: 1.3 ha

Total Burrows: 502 ± 210

1986 Occupancy Rate: No occupancy rate was determined. Regurgitated food was found at the entrance to burrows, indicating the presence of hatched chicks.

1986 Nesting Population: 377 ± 158 pairs estimated (using median B.C. occupancy rate of 75%).

Rhinoceros Auklet: Rhinoceros Auklets were nesting in two disjunct pockets on the south and west sides (Fig. WM100-1, Table WM100-7). Burrows were located under tree roots and logs, on slopes of 25 to 45° (average = 33°). Most burrows were within 30 m of the vegetation edge.

Number of sample plots: 7 (63 m^2 - 1.0% of colony)

Average Density: 629 ± 471 burrows/ha

Colony Area: 0.6 ha

Total Burrows: 391 ± 293

1986 Occupancy Rate: No occupancy rate was determined.

1986 Nesting Population: We estimated 301 ± 226 pairs (with median B.C. rate of 77%).

Predation: We found depredated remains of Fork-tailed Storm-Petrel (22 single wings, 1 pair of attached wings, 2 feather piles, and 5 dug-up burrows with feathers scattered about), Leach's Storm-Petrel (6 single wings, 1 pair of attached wings, 2 feather piles, and 2 dug-up burrows with feathers), Ancient Murrelet (8 single wings, 1 pair of attached wings, 4 feather piles, and 1 eggshell), Cassin's Auklet (3 pairs of attached wings, and 2 feather piles), and Glaucous-winged Gull (1 feather pile) during our exploration. Six other unidentified storm-petrel burrows had been dug-up. Along the transects the density of Fork-tailed Storm-Petrel remains found in the quadrats was calculated to be 137 ± 76 feather piles per hectare (Table WM100-8) which would represent 507 ± 281 Fork-tailed Storm-Petrels preyed upon this season up to the time of our survey. The minimum number of birds represented by remains of Leach's Storm-Petrels in the quadrats was 2 (3 single wings) which yields a density of 92 ± 63 birds/hectare. Extrapolating over the whole colony gives an estimate of 340 ± 233 Leach's Storm-Petrels preyed upon this season.

We found River Otter dens and trails on the island. At one site, many of the scats contained mostly feathers. There was a Bald Eagle nest near the west end (see below).

Table WM100-7. Number of Rhinoceros Auklet burrows in 3x3 m plots along transects on Luxmoore Island in 1986. Plots considered outside the colony are indicated by a dash.

Transect	Plot number						
	1	2	3	4	5	6	7
1	-	-	-	-	-	-	
2	3	0	0	-	-	-	-
3	-	-	-	-	-	-	-
4	0	0	0	1			

Table WM100-8. Depredated remains of storm-petrels and Cassin's Auklets found in plots along transects on Luxmoore Island in 1986.

		Storm-petrels					Cassin's Auklet
Tran	Plot	FTSP wing	FTSP feather pile	LSPE wing	LSPE feather pile	Dug-up burrow	Single wing
1	2	2	1				
1	3		1			2	
1	6						1
2	1	1					
2	4					1	
2	6					1	
2	7			1			
4	1			2	1		
4	2		1				

Associated species:

Bald Eagle - 2 adults, 1 subadult on 15 May. One nest on the south side near the west end: 20 m high in 30 m spruce near the edge of the vegetation. One adult sitting on the nest, and another flying by.

Black Oystercatcher - heard calling.

Northwestern Crow - 3

River Otter - runs and dens.
Sitka Deer - trails
Northern Sea-Lion - 7 in water at west end.

Other sightings:

Rufous Hummingbird
Winter Wren
Varied Thrush

WM-110 ROGERS ISLAND 103 C/16

Location: Englefield Bay, on the west side of Hibben Island, north of Cape Kuper. 52°58'36"N 132°20'W

Land status: Provincial Crown Land.

Date of survey: 15 May, 1430-1700 h (exploration), and 28 May 1986 (transects).

Colony access: Drop-off from boat.

Observers: M. Lemon, D. Garnier, A. Eisenhawer, H. Hay.

Census method: 25 quadrats (3x3 m) spaced 15 m apart along 2 transects spaced 75 m apart and run at a bearing of 360° (Table WM110-1).

Table WM110-1. Transect parameters on Rogers Island in 1986.

Transect	Bearing (°)	Total length (m)	Elevation			Average slope (°)	Range of slopes (°)
			Beg. (m)	End (m)	Max. (m)		
1	360	165	25	12	25	22	3-45
2	360	211	40	3	60	26	3-50

Description: Rogers is a 8.0 ha island, rising to a maximum elevation of 60 m. The rocky shore is cliffy and dissected. Most of the interior of the island is covered with 10-14 m high young spruce and dispersed 0.2-0.4 m dbh spruce, with scattered large spruce (0.9-1.5 m dbh) and hemlock (0.7-1.0 m dbh) throughout the area. Perimeter slopes are grassy and often wet. On the small, connected eastern islet, there is considerable windfall, both old and recent.

Nesting species:

Storm-petrel: Storm-petrels were nesting in most areas, except wet, grassy slopes (Fig. WM110-1, Table WM110-2). Burrows occurred throughout the young spruce, under windfall, and on drier grassy slopes. Burrow entrances were located under tree roots, fallen trees and into the open ground (Table WM110-3). They were clustered around tree bases and upturned roots on the eastern islet.

Number of sample plots: 25 (225 m^2 - 0.3% of colony)

Average Density: 4804 $\pm$ 834 burrows/ha (Table WM110-4)

Colony Area: 6.6 ha

Total Burrows: 31,586 $\pm$ 5483

1986 Occupancy Rate: No occupancy rate was determined. Leach's Storm-Petrels were heard calling from burrows, and depredated remains of both Fork-tailed and Leach's storm-petrels were found (see Predation below). Spruce fronds and moss were found in burrow tunnels and piles of fresh earth were found at the entrances to some burrows.

1986 Nesting Population: Using the median B.C. occupancy rate of 91%, we estimated 28,743 $\pm$ 4990 pairs of storm-petrels nesting.

Black Oystercatcher: On 28 May, there was 1 pair on the southeast end. We found 1 empty scrape of rock chips.

Pigeon Guillemot: We observed Pigeon Guillemots flying out of burrows and crevices along the south side. There were 20 birds on the water in this area on 15 May at 1430 h.

Ancient Murrelet: We found Ancient Murrelet burrows over much of the area on the main part of the island. They were absent from the small eastern islet, and from the central portion of the main island (Fig. WM110-1, Table WM110-2). Burrows were located on slopes of 3 to 45° (average = 22°) under roots and tree bases (Table WM110-3).

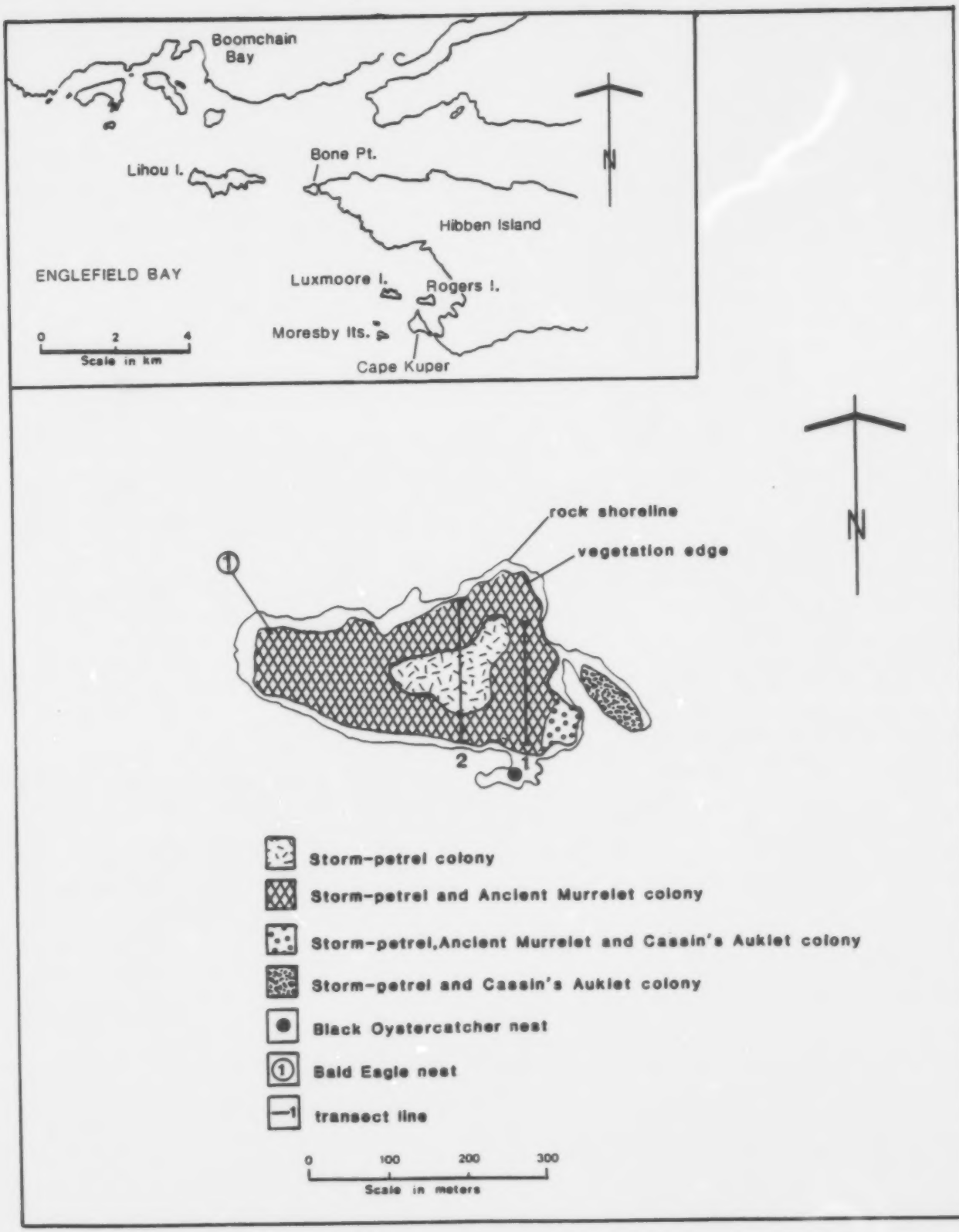


Figure WM110-1. Seabird colony areas and transect locations on Rogers Island in 1986.

Table WM110-2 Extent of storm-petrel and Ancient Murrelet colonies on Rogers Island in 1986.

	Storm-petrel					Ancient Murrelet				
		Distance from nearest vegetation edge					Distance from nearest vegetation edge			
Tran	Dist. along transect (m)	Min. (m)	Max. (m)	Range of elevation (m)	Average slope (°)	Dist. along transect (m)	Min. (m)	Max. (m)	Range of elevation (m)	Average slope (°)
1	0-165	0	50	12-25	22	0-165	0	50	12-25	22
2	0-211	0	120	3-60	26	0-37	0	67	40-55	24
						127-211	0	83	3-24	21

Table WM110-3. Habitat locations of storm-petrel and Ancient Murrelet burrow entrances in plots along transects on Rogers Island in 1986.

Location	Storm-petrel		Ancient Murrelet	
	Number of burrows	Percent of total	Number of burrows	Percent of total
Tree base	4	4		
Live tree roots	31	29	4	44
Under stumps	3	3	1	11
Dead tree roots	15	14	2	22
Fallen tree/log	30	28		
Grass tussock	2	2		
Open ground	17	16	1	11
Into bank	6	6	1	11
Total	108		9	

Table WM110-4. Number of storm-petrel burrows in 3x3 m plots along transects on Rogers Island in 1986.

Transect	Plot number													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	11	1	6	9	5	0	5	0	6	8	0			
2	3	6	10	8	0	5	11	6	0	2	0	4	0	2

Number of sample plots: 19 (171 m^2 - 0.3% of colony)

Average Density: 521 ± 197 burrows/ha (Table WM110-5)

Colony Area: 5.2 ha

Total Burrows: 2690 ± 1007

1986 Occupancy Rate: No occupancy rate was determined.

1986 Nesting Population: 1692 ± 634 pairs estimated (with median B.C. rate of 63%).

Cassin's Auklet: Cassin's Auklet burrows were sparsely scattered on the southeast corner of the main island and on the small, eastern islet. We estimated there were no more than 50 burrows in total with about 40 pairs nesting.

Rhinoceros Auklet: A few, sporadic burrows occurred in the same areas as Cassin's Auklets. We estimated 20 pairs nesting.

Predation: There was ample evidence of predation on storm-petrels. More than 50 single wings were found. Most of these were of Fork-tailed Storm-Petrels, but some were Leach's Storm-Petrels. Along the transects, 5 storm-petrel feather piles were found in surveyed quadrats, a density of 220 ± 90 feather piles per hectare (Table WM110-6). Extrapolating this over the colony yields an estimate of 1452 ± 594 depredated storm-petrels at the time of our survey. Five storm-petrel burrows were found that had been excavated by some predator. A river otter den was located between transects 1 and 2. Scats around the runs contained some feathers along with fish remains, and storm-petrel feathers and 8 Fork-tailed Storm-Petrel wings were found in the vicinity.

Associated species:

Bald Eagle - One nest on the northwest corner: 18 m high in 28 m spruce, 10 m from the edge of the vegetation. One adult was present.

Northwestern Crow

River Otter - runs and dens.

Other sightings:

Hairy Woodpecker - skeleton
Townsend's Warbler

Table WM110-5. Number of Ancient Murrelet burrows in 3x3 m plots along transects on Rogers Island in 1986. Plots considered outside the colony are indicated by a dash.

Transect	Plot number													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	1	1	0	1	0	0	3	0	0	0	1			
2	0	0	0	-	-	-	-	-	-	1	0	0	0	1

Table WM110-6. Depredated remains of storm-petrels found in plots along transects on Rogers Island in 1986.

Transect	Plot	FTSP wing	FTSP feather pile	LSPE wing	Storm-petrel feather pile
1	4				1
1	5		1		
1	7			1	
2	3		1		
2	4		1		
2	6				1
2	7	3			
2	12	2			

WM-120 CAPE KUPER 103 C/16

Location: Englefield Bay at the southwest corner of Hibben Island.
52°58'15"N 132°20'20"W

Land status: Provincial Crown Land.

Date of survey: 15 May, 1800-1845 h, 28 May 1986, 1300-1820 h.

Colony access: Drop-off from boat.

Observers: M. Rodway, M. Lemon, D. Garnier, A. Eisenhawer, D. Grinnell.

Census method: Total count.

Description: Cape Kuper is separated from the main Hibben Island by a narrow tidal channel. Much of the perimeter of Cape Kuper is steep, rock bluff, especially on the west side. Deep gorges cut inland along the southwest shore. The interior is a series of undulating ridges and knolls. It has a total area of 20.1 ha, and rises to a maximum elevation of about 70 m.

The forest is predominantly spruce on the narrow north and south tips, and along the western sides. Hemlock is more abundant on the higher, interior slopes. Western slopes within 30 m of shore rock are generally grassy (Calamagrostis), but extensive areas are covered with thick, young spruce and hemlock (1-8 m tall), especially towards the north end where it covers most of the central area. There are scattered larger spruce (0.4-1.1 m dbh), and spruce snags standing through these tracts of regeneration. The high interior of the cape has an open, mossy forest floor, with many clear, seaward facing slopes along the east side. The northern slopes of this interior area are wetter, with lots of old, mossy deadfalls on the ground.

Nesting species:

Ancient Murrelet: We found 14 burrows that we attributed to Ancient Murrelets. One burrow contained an eggshell, and one contained Ancient Murrelet feathers. Burrows were sporadic along the western perimeter: 4 were located on a knob about 200 m south of the north tip, and the rest were scattered along the outer west side in association with Cassin's and Rhinoceros Auklets. Entrances were under tree roots in grassy areas within 5 m of the edge. We estimated 10 pairs nesting.

Cassin's Auklet: Cassin's Auklets were nesting in small, disjunct pockets along the western perimeter (Fig. WM120-1). Burrows were under roots and stumps in grassy areas; few were in the grass itself. On the southwest point facing Moresby Islets (just west of the deep gorge), burrows extended as far as 10 m from the edge of the vegetation. Other pockets were within 3-5 m of the edge.

We counted a total of 162 burrows. Burrows appeared well used, with droppings, regurgitated food and feathers at the entrances. We found one hatched eggshell. The nesting population was estimated to be 120 pairs (using the median B.C. occupancy rate of 75%).

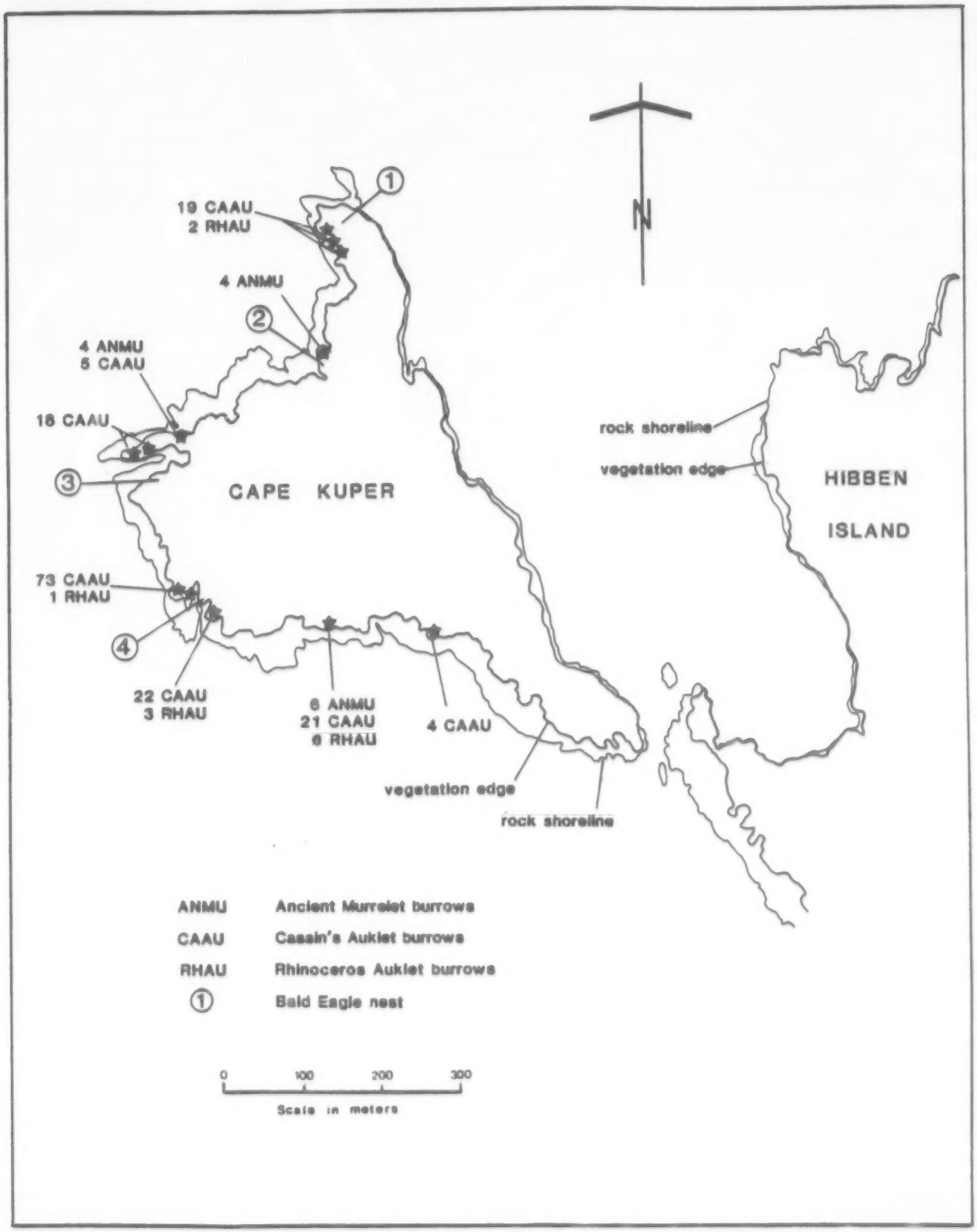


Figure WM120 -1. Seabird colony areas on Cape Kuper in 1986.

Rhinoceros Auklet: Rhinoceros Auklets were nesting in the same areas as Cassin's Auklets, though much less frequent. We counted a total of 12 burrows. Burrows were large and well worn, with droppings at the entrances. We found one Rhinoceros Auklet feather pile. We suspected 10 pairs nesting.

Associated species:

Bald Eagle - 4 nests were found.

1. At north point: 20 m high in 25 m spruce 10 m from west edge.
2. On west side, 200 m south of north tip: 22 m high in 25 m spruce, 5 m from edge of vegetation. 1 adult present and calling.
3. On northwest corner of outer west side: 10 m high in spruce 20 m from the edge. Two adults present and flying into nest.
4. On southwest corner of outer west side: 15 m high in 25 m spruce, 50 m from shore rock. One adult present and excited.

Northwestern Crow - 20+ seen. Three nests: 1 with 3 eggs, 1 with 1 young, and 1 with 2 young.

Common Raven - 2

River Otter - dens and runways along east side; scats of fish remains; one seen swimming off south side 15 May 1986.
Hair Seal - four
Red Squirrel - One seen near the south tip on the west side at the base of a spruce tree at shore. Runways and tunnels under large root complex nearby. Lots of spruce cone chewings.

Other sightings:

Red-breasted Sapsucker - one dead found in small hole in rock bluff
Northern Flicker
Winter Wren
Hermit Thrush
Varied Thrush
Townsend's Warbler
Song Sparrow

WM-130 MORESBY ISLETS 103 C/16

Location: Englefield Bay, west of Cape Kuper. 52°58'06"N 132°21'15"W

Land status: Provincial Crown Land.

Date of survey: 15 May 1986, 1420-1745 h.

Colony access: Drop-off from boat.

Observers: M. Rodway.

Census method: Exploration and partial count.

Description: Moresby Islets consist of two separate islets. The smaller, 2.0 ha, northwest islet is mostly bare rock, eroded into contorted pockets, ridges and sinkholes. There is a shallow, caldron-like "lake" in the middle of the islet, with a small patch of grass on its shore. On the northeast corner is an isolated rock pinnacle.

The 5.3 ha, south islet has steep, rocky sides, and rises to 50-60 m elevation. Towards the west end, there is a gorge which constricts the island and partially separates the southeastern section from the rest. The vegetation begins at about 30 m elevation on this islet. The west section, and all the southern slopes are covered with grass (primarily Calamagrostis) and forbs (Angelica, Maianthemum, Ranunculus, Saxifraga) under mature spruce (0.4-1.0 m dbh). Except for a narrow, grassy fringe, the northern slopes have a bare litter floor under smaller spruce (0.1-0.2 m dbh). At the crest of the northern slope, there is a border of only 2-5 m tall spruce. There are some large spruce (0.8-1.0 m dbh) scattered over the northern slopes, and patches of young, and windswept spruce occur on the west end. Salmonberry and currant grow along bluff edges on the northwest corner.

Nesting species:

Storm-petrel: No sign of nesting by storm-petrels was found.

Black Oystercatcher: There were two oystercatchers on the northwest rock, but no nest was found, and the birds were not defensive.

Glaucous-winged Gull: One pair of gulls was standing on the northeast pinnacle of the northern islet. We found a possible scrape where the gulls may have been beginning to build a nest.

Pigeon Guillemot: There was one Pigeon Guillemot between the islets.

Ancient Murrelet: We found 1 burrow, 10 m from the edge of the vegetation on the northwest corner of the main section of the island (ie. east of the gorge), that may have been an Ancient Murrelet burrow. No evidence of nesting was obtained, and we saw no other possible Ancient Murrelet burrows. There was 1 bird on the water between the islets at 1440 h.

Cassin's Auklet: Cassin's Auklet burrows were scattered around the fringe of the vegetation. On the north side, burrows occurred in the grassy fringe or just on the edge of the bare litter interior. On the south side, burrows were in the grass within 10-15 m of the edge. Burrows were located under tree roots

and logs. On the south side, all burrows were clustered around tree bases, none were found in open grass. We counted a total of 53 burrows, and estimated there were about 100 burrows in all. Burrows appeared well used, with droppings and regurgitated food at their entrances. Seventy-five pairs were suspected nesting.

Rhinoceros Auklet: Rhinoceros Auklets were nesting in the same fringe areas as Cassin's Auklets. We found three burrows about 40 m from the edge on the south side, but most were within 10-15 m of the shore rock. We discovered one burrow under grass in the open on the south side, otherwise burrows were confined around tree bases like the Cassin's Auklets. We counted 24 Rhinoceros Auklet burrows, and estimated a total of 50 burrows on the island. Burrows appeared active, with droppings around the entrances, and we estimated 40 pairs nesting.

Predation: We found three single Cassin's Auklet wings, two Sooty Shearwater wings, and one Northern Fulmar skull.

Associated species:

Pelagic Cormorant - 6 in breeding plumage and 1 immature in a feeding ball off the northeast corner at 1735 h.

Bald Eagle - 3 adults and 3 immatures in feeding ball.
One nest at east end of highest ridge line: 25 m high in 30 m spruce.

Marbled Murrelet - 1 between the islets.

Northwestern Crow - 1 nest with 3 eggs, and 1 empty nest. Adult feeding 2 young. Four adults seen.

Northern Sea-Lion - 60 hauled out on the east end of the northern islet. No large males were present.
River Otter - runs and scats of fish.
Sitka Deer - trails

Other sightings:

Common Merganser - 1 pair in feeding ball
Winter Wren
Orange-crowned Warbler
Fox Sparrow
Song Sparrow

Including rock south of Louscoone Point.

Location: North of Anthony Island at the mouth of Louscoone Inlet. 52°06'50"N 131°13'35"W

Land status: Part of South Moresby National Park Reserve.

Date of visit: 29 May 1985 (1100-1130 h) and 17 June 1986 (1100-1228 h).

Colony access: Drop-off from boat.

Observers: 1985: D. Power, M. Rodway. 1986: M. Rodway, D. Garnier, D. Grinnell.

Census method: Exploration and total count.

Description: There were four islets where nests were located with a total area of 2.4 ha. These were numbered south to north (Fig. WM270-1). The higher portion of the main islet #1 is grassy with a small clump of windswept spruce. Calamagrostis mixed with Maianthemum, Montia, and Conioselinum pacificum covers most of the vegetated area. Elymus mollis grows around the edges. The lower areas of this islet and the other islets are mostly bare rock.

Nesting species:

Black Oystercatcher: In 1985, 1 nest with 3 eggs was found on the main island. It was made of rock chips. Two adults were present. In 1986, the following nests were found:

Islet	2E	1Y	Total	Adults
1	1	1	2	8
2			0	
3				2
4	1*		1	2
TOTALS	2	1	3	12

*(plus 1 Glaucous-winged Gull egg)

Nests were made of rock chips and limpet and mussel shells. The nest on islet 4 with the Glaucous-winged Gull egg also contained Cochleria officinalis stems. The oystercatcher was incubating the eggs.

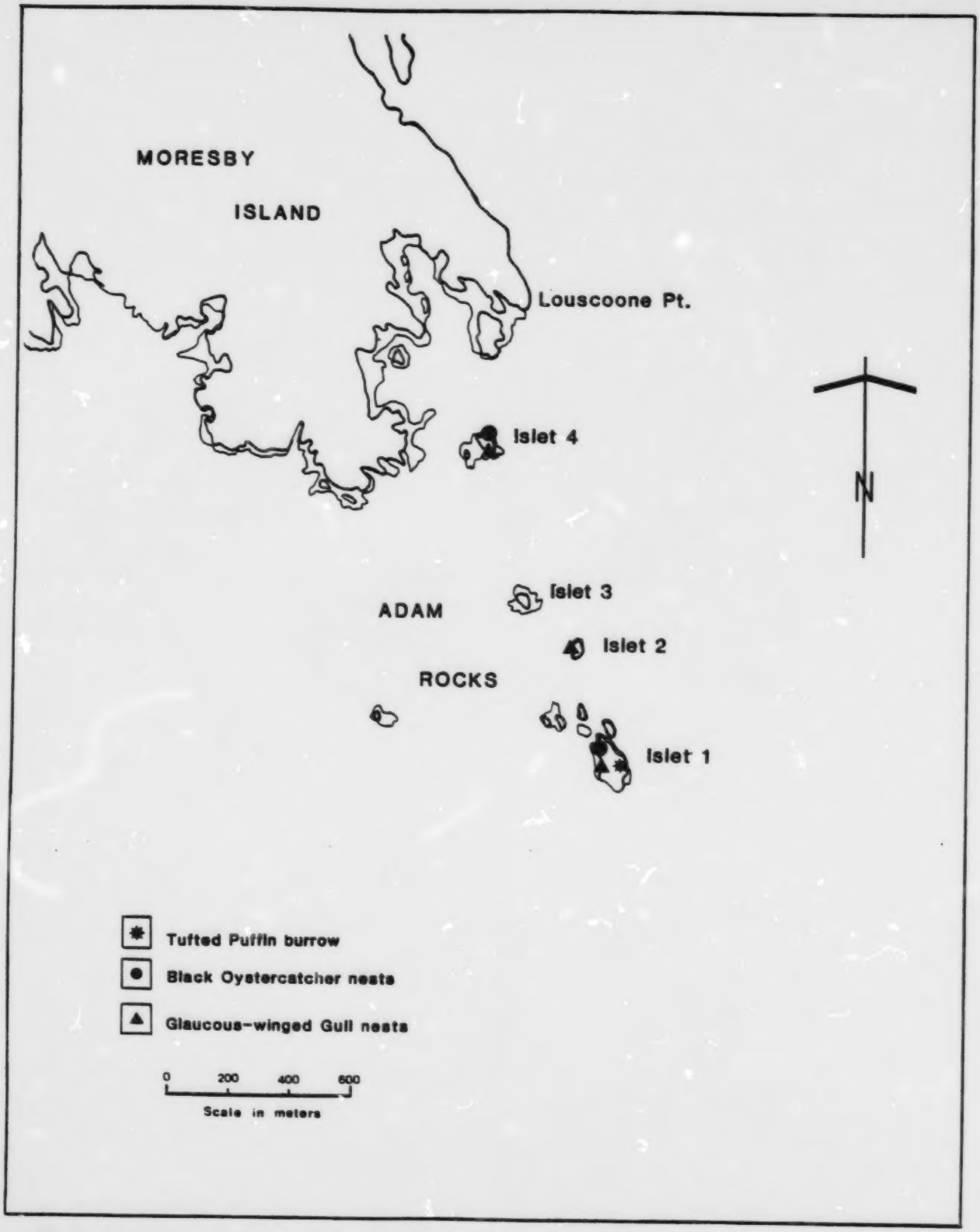


Figure WM270-1. Seabird nesting sites on Adams Rocks in 1986.

Glaucous-winged Gull: In 1985, 70 adults were counted on territory and flying. We found 6 nests just begun: depressions had been made and bits of Maianthemum, grass and Cochlearia had been collected. In 1986, the following nests were counted:

Islet	Start	Empty	1E	2E	3E	Total
1	3	2	1	5	32	43
2		2	1	1		4
3						0
4	1					1
TOTALS	4	4	2	6	32	48

Nests were made of grass, moss, seaweed, Maianthemum, Saxifraga, Conioselinum, and Cochleria.

Pigeon Guillemot: In 1985, 24 were on the rocks and in the water on the east side of the main island. One pair was observed copulating. In 1986, we counted 20 around the main island.

Tufted Puffin: In 1985, we found one large burrow in a crevice at the edge of the vegetation on the east side of islet #1. The entrance and the tunnel were well worn. One adult was flying around this area while we were there. No other burrows were found. We saw four adults flying around this area in 1986.

Associated species:

Pelagic Cormorant - 33 (2 in breeding plummage) roosting on Islet 3 in 1986.

River Otter - We noted runs and scats through the grassy area.

Hair Seal - There were 10 hauled out on the rocks in 1985.

Other sightings: in 1986:

Harlequin Duck - 1 male
Song Sparrow
Pine Siskin

Location: Off the southwest coast of Moresby Island, west of Kunghit Island. 52°05'40"N 131°13'W.

Land status: On the east coast of Anthony Island are the remains of the Haida village of Ninstints, which have earned it the designation of a United Nations World Heritage Site. "Skungwai" is the old Haida name for the island and means "red cod island". The small group of islands off the south end of the island are protected as an Ecological Reserve administered by the British Columbia Ministry of Lands, Parks and Housing. The entire area has recently become part of the South Moresby National Park Reserve.

Date of visit: M. Rodway and M. Lemon made a brief visit to the island on 3-5 June 1982. The main survey of the islands was conducted from 19 May to 4 June 1985. Eight Permanent Monitoring Plots for Rhinoceros Auklets were also established at this time (see Appendix II). The area was revisited on the 16 and 17 June 1986 to count surface nesting species.

Colony access: Landing beaches on the main island at Ninstints, along the north side, and in the mid-west bays when seas were not too rough. Islet #23 has a small beach on the south side. Landing is feasible on islet #1 at the appropriate tide.

Base camp: With special permission we camped at the south end of Ninstints. Normally camping is not permitted. The closest alternate site that we used was in the bay north of Bowles Point on Kunghit Island. Water was available in the bay just south of Bowles Point.

Observers: 1982: M. Lemon, M. Rodway. 1985: M. Lemon, M. Rodway, D. Garnier, D. Power. 1986: M. Rodway, D. Garnier, D. Grinnell.

Census methods:

Exploration: We spent two days (20 and 22 May 1985) exploring the entire perimeter of the main island, except for some of the very steep, cliff-rimmed edges along the southwest side. We searched every vegetated ridge and knob around the island, and frequently zig-zagged from the perimeter into the interior at least 100 m. We traversed across the island in many places to check for signs of burrowing. In all areas where burrowing was encountered we explored to determine its boundaries. Cassin's Auklet and Rhinoceros Auklet colony areas were subsequently transected. Ancient Murrelet burrows were too sparsely and sporadically distributed to be transected and so we only estimated their population from what we observed on our explorations.

We spent a total of four days exploring and transecting the surrounding islands. In 1985, all islands were visited except four outer ones at the southwest end (#24-27, Fig. WM280-1). These were explored in 1986 when the surface nesting species were censused. A number of the small islets had only a few burrows which we total counted (islets #3,8,9,10,11,12,13,16,17,18,22, and 25). Others that had larger numbers of nesting petrels and auklets were transected (islets #2,4,5,6,7,15,20,21, and 23). See specific islet descriptions for more detail. In 1986, Pelagic Cormorant, Black Oystercatcher, and Glaucous-winged Gull nests were total counted in all areas except on two inaccessible pinnacles on islet #1.

Transects: On the main island we ran 26 transects with a total of 116 quadrats (3x3 m) located at 15 m intervals to census the Cassin's Auklet and Rhinoceros Auklet nesting areas (Fig. WM280-1, Table WM280-1). Transects along the northeast side were run in parallel groups and were evenly spaced 75 m apart. On the more precipitous and dissected southwest side, transects were placed where the terrain permitted. On the surrounding islets, we ran a total of 11 line transects, with 58 plots (3x3 m), and 14, 1 m wide strip transects (for petrels). See specific islet accounts for more detail.

Colony areas were mapped on an enlarged airphoto (scale 1:10000) from explorations and slopes and ground distances determined along transects. For sections along the northeast side of the island (transects 1-14) and around transects 22-26 on the west side of the island, colony areas were mapped on graph paper, using field measurements, and surface areas were calculated from those planar representations.

Distinguishing species: On the southwest side of Anthony Island, Cassin's Auklets and Rhinoceros Auklets were burrowing in the same areas. Where birds could not be reached in burrows, distinction of species was based on the criteria outlined in the methods section.

On the surrounding islets, petrels were burrowing in areas with the auklets, but little difficulty was encountered differentiating petrel from auklet burrows according to size. The musty odour of petrels was also helpful.

Occupancy Rates: Single occupancy rates for Cassin's and Rhinoceros Auklets were determined for all islands. No attempt was made to determine separate rates on each islet. In individual island accounts only total burrow numbers are given. See the species summaries following the islet accounts for estimates of 1985 occupancy rates and nesting populations. No occupancy rate was determined for storm-petrels as we were too early in the season to obtain a dependable rate for Leach's Storm-Petrels.

Description: There are 27 smaller islets surrounding Anthony Island. The total area of the entire group (main island and small islets) is 170 ha. The vegetated area comprises 117.4 ha. Each island with its nesting species is described separately, beginning with the main island. A summary of the species distribution and populations follows all the island accounts. Predation evidence is also summarized following the island accounts. The specific dates, observers and methods are listed for each island.

ANTHONY ISLAND (main island)

Date of survey: 20,22,24,25,30,31 May and 1,2 June 1985.

Observers: M. Lemon, M. Rodway, D. Garnier, D. Power.

Census method: 116 plots (3x3 m) on 26 transects (Table WM280-1). An occupancy plot was set up in the colony south of the old village site, and surveyed on 1 June 1985.

Table WM280-1. Transect parameters on Anthony Island and surrounding islets in 1985. Transects marked with a star were begun away from the vegetation edge.

Tran	Bearing (°)	Transect length (m)	Elevation of transect Beg. (m)	End (m)	Max. (m)	Average slope (°)	Range of slopes (°)
Northeast side main island							
1	239	11	10				
2	239	18	3	3	3	2	0-3
3	239	30	4	12	12	14	1-27
4	239	15	3	3	8		
5	237	33	10	10	12	14	8-22
6	237	33	5	10	10	21	2-40
7	243	48	10	20	20	17	5-24
8	243	78	2	28	28	17	2-29
9	243	93	10	40	40	17	2-28
10*	243	48	30	35	36	10	4-24
11*	243	93	15	30	30	15	3-30
12	243	63	2	20	20	11	0-31
13	243	48	5	10	10	16	8-32
14	243	18	9	12	12	9	3-15
Southwest side main island							
15	68	48	24				
16	50	48	10	35	35	32	28-40
17	90	108	15	40	40	16	4-23
18*	50	48	40	75	75	31	10-50
19*	42	63	50	75	75	23	8-35
20*	19	78	20	60	60	27	8-47
21	50	30	5	10	10	10	3-16
22	293	45	1	22	22	21	8-30
23*	35	150	10	30	30	22	2-45
24	298	60	15	13	18	13	5-30
25	317	50	25	33	33	26	14-40
26	29	46	30	20	30	25	12-35
North islet #2							
1	34	51	10	10	15	22	4-40
2	61	95	10	15	25	21	4-38
3	42	67	15	15	20	20	4-35
4	42	90	15	15	20	22	2-48
Islet #4							
1	205	110	20	20	20	15	3-35
Islet #15							
1	40	33	2	4	1	9	0-16
Islet #20							
1	351	91	15	15	20	20	10-40
Islet #21							
1	10	48	20	6	22	30	9-50
Islet #23							
1	340	135	3	3	10	25	8-48
2	340	96	2	4	6	10	0-30

Description: The main island is 130 ha in size and reaches a maximum elevation of about 75 m along the southwest side. The northeast side of the island consists of a series of undulating ridges and knolls with a number of small cliffs facing the sea. South of Ninstints is a continuous set of deeply cleft cliffs, about 10 m high. At the south end of these cliffs is a small lake perched just behind the high tide rock. The southwest side of Anthony presents a more formidable aspect with 30-40 m cliffs cut by deep gorges dropping to the sea. Higher ridges and knolls running in a southeast to northwest direction parallel the coast on this side. Towards the north end these create an alternating series of bays and ridges, and also surface to create the series of small islets offshore.

Anthony has 104 ha of vegetated habitat. The forest is a typical mix of Sitka Spruce, Western Hemlock and Western Redcedar, with spruce more predominant near shore, especially along the more exposed west coast, and hemlock and redcedar more abundant inland (Fig. WM280-2). Redcedar dominates in some interior areas, especially just northwest of the lake on the interior slope of the east ridge, where it is small and contorted. There is a large, uniform stand of second growth hemlock and redcedar (average dbh = 0.4 m) with lots of small deadfall along the east side behind Ninstints. It extends approximately 500 m north and south of the village site, and almost halfway across the island towards the west bays. It is probably the result of cutting and burning by the inhabitants of Ninstints who lived there until about 1890. On the west side are large tracts of old windfall, now covered with thick, young (<10 cm average dbh) regenerating spruce. A few large live spruce and some snags still stand over these areas. Sitka Alder and wild crabapple (Malus diverifolia) occur along the east shore.

Much of the understory along the east side and into the interior is bare litter with some moss. Grass, primarily Calamagrostis, covers many of the knolls and ridges along the west side, and rims the forest along the north and east sides. There is an area of thick salal on the middle peninsula on the northwest end, and salal occurs along cliff edges on the east and west sides. It is scattered with huckleberry (Vaccinium sp.) in the interior. Its extent has likely been reduced by the deer. On some of the ridges towards the south end the ground was littered with dead salal stalks. There are wet seepage areas in the meadow southwest of Ninstints and in the low lying areas south of the small lake.

Nesting species:

Pelagic Cormorant: Cormorants were nesting in two deep gorges in the cliffs on the southwest side of the island. In 1985, a maximum of 15 breeding birds were seen carrying nesting material into the gorges on 25 May. Four nests were visible on 29 May. In 1986, 14 nests were counted in the two gorges, 7 in each. Adults were sitting on the 7 nests in the southern of the two gorges. The other 7 were unattended. 26 birds (only 2 with breeding patches) were flying around the cliffs. We suspect there were only 7 pairs nesting.

Black Oystercatcher: On 20 May 1985, there were two adults attending an empty scrape at the south end on the east side. The scrape was made of rock chips and limpet and mussel shells. In 1986, we found 1 empty scrape on the rocky area at the northwest corner. There was 1 adult present.

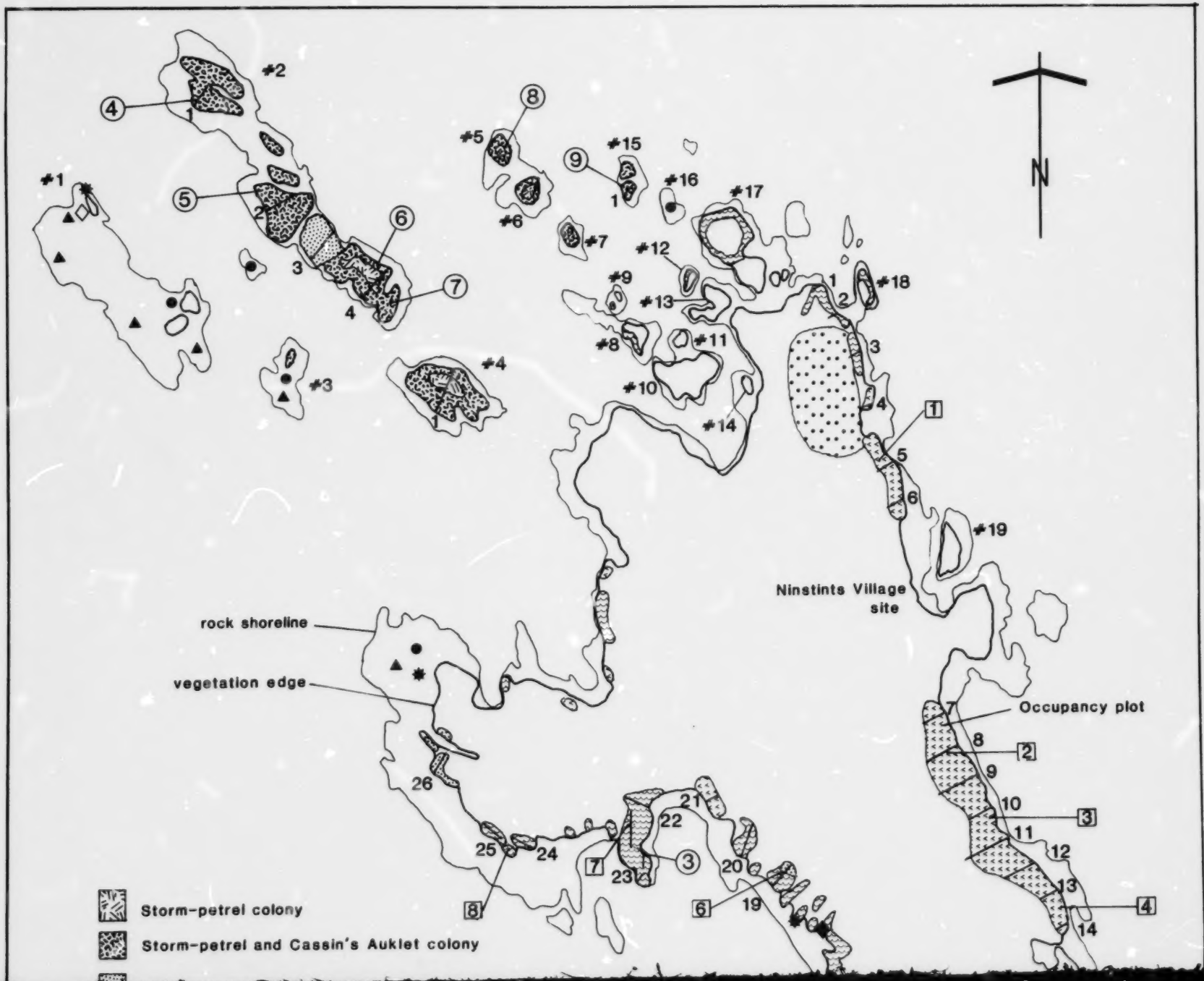
Glaucous-winged Gull: In 1986, there were 6 nests on the northwest point: 2 starts and 4 with 3 eggs.

Pigeon Guillemot: We regularly observed Pigeon Guillemots around much of the island. Regular groups occurred below the cliffs south of Ninstints (maximum 21 on 21 May 1985), outside the main bay of Ninstints (maximum 55 on 20 May 1985), off the north end amongst all the the northern islets (maximum 267 on 28 May 1985), and on the west side of the island (maximum 10 on 22 May, 1985). Birds also occurred around the southern islets (see following accounts and species summary for all the islets). In 1986, we found 1 nest with 1 egg on the northwest corner of the main island.

Ancient Murrelet: Ancient Murrelets were nesting sparsely under spruce, hemlock and redcedar on the undulating interior ridges towards the north end of the island (Fig. WM280-1). We found depredated birds and eggshells but no birds were actually pulled from burrows. A few adults were heard calling during most nights of our stay in 1985. We heard one pair of chicks calling on the night of 2 June 1985. Due to the sparse distribution of burrows, we did not attempt to transect the area to determine their numbers. From our exploration we estimated about 200 nesting pairs.

Cassin's Auklet: The main concentration of Cassin's Auklets occurred along the southwest side of Anthony Island. They were nesting on the slopes above the cliffs south of the west bays, and on a number of the ridges and knolls, both at the south end and on the outer west side (Fig. WM280-1). Burrowing extended from the shore edge in some areas, to as far as 90 m inland (average width = 42 m), and from 1 m elevation at the shore vegetation edge to as high as 75 m, above the southwest cliffs (Table WM280-2). The slope in this colony area ranged from 2 to 50° (average slope = 24°). Burrows were located under grass tussocks, tree roots, logs, thick, regenerating young spruce, as well as into the ground in mossy or bare areas (Table WM280-3). Burrows extended as far as 30 m into areas of thick, young spruce (<10 cm dbh). On some of the grassy knobs on the west side, Cassin's Auklets were burrowing throughout the vegetated areas, while on others, especially towards the southern and northern ends, they were nesting only on the seaward rims. There were only a few burrows scattered around the shoreline at the north end of the island.

Cassin's Auklets were nesting in the same areas as Rhinoceros Auklets in much of the habitat on the west side. On the slopes above the southwest cliffs, Rhinoceros Auklet burrows were more abundant lower on the slopes and around the edges, and Cassin's Auklets became abundant higher on the slopes and extended further inland. On the knolls and ridges towards the outer west side, the distribution of the two species was intriguing. On one knoll just west of the western-most south facing bay, we found almost all Rhinoceros Auklet burrows, while on the adjacent knoll less than 50 m away, there were mostly Cassin's Auklet burrows. On the ridge between the two south facing west bays, Rhinoceros Auklets extended along the crest, while Cassin's Auklets were found primarily near shore and only sparsely higher on the ridge. Cassin's Auklets occurred in isolation at the very south tip and the outer west tip of the island. We found no Cassin's Auklet burrows in the main Rhinoceros Auklet colony area south of Ninstints on the northeast side, and only a few in association with Rhinoceros Auklets at the north end.


N
Ninstints Village site
rock shoreline
vegetation edge
Occupancy plot
Storm-petrel colony
Storm-petrel and Cassin's Auklet colony

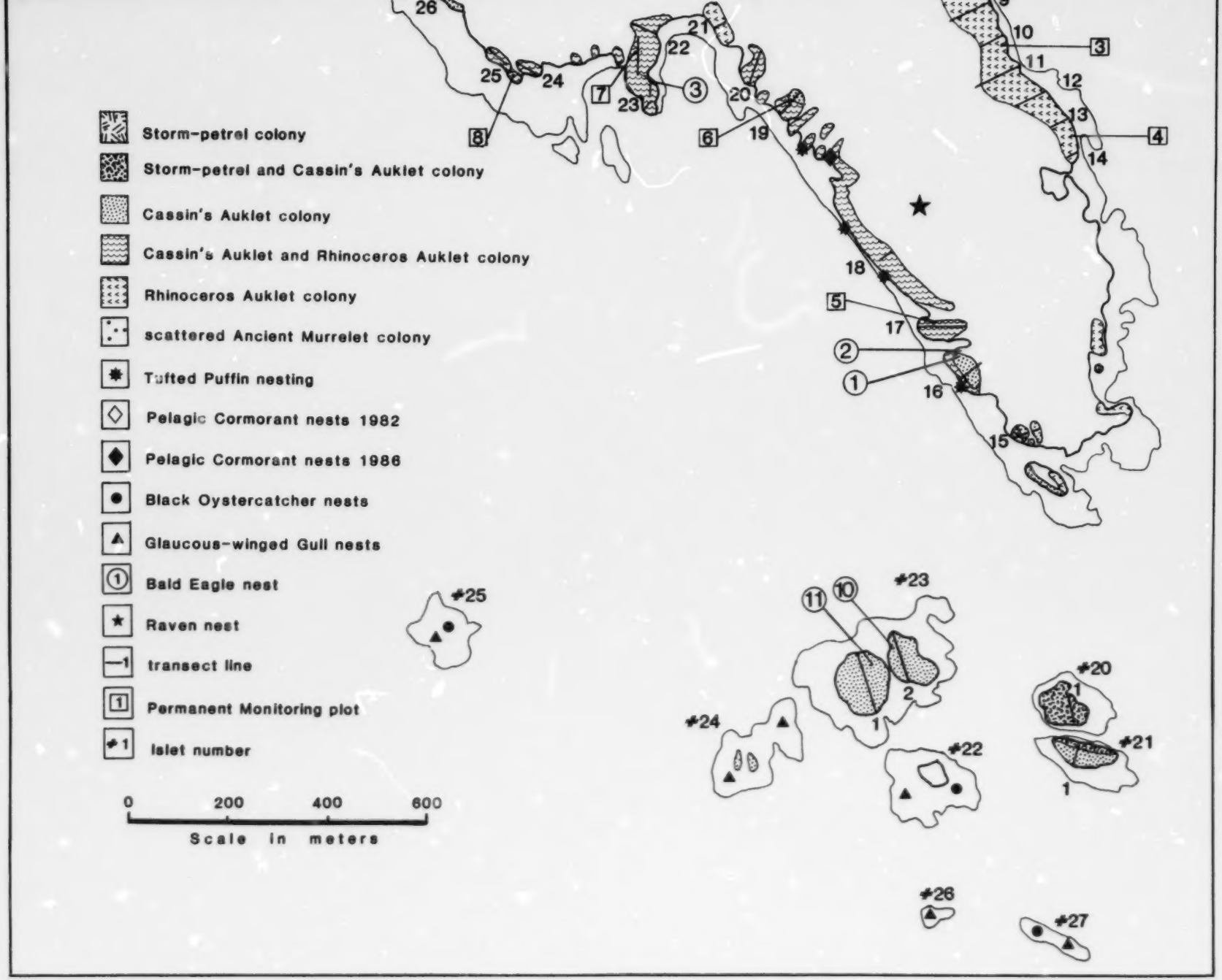
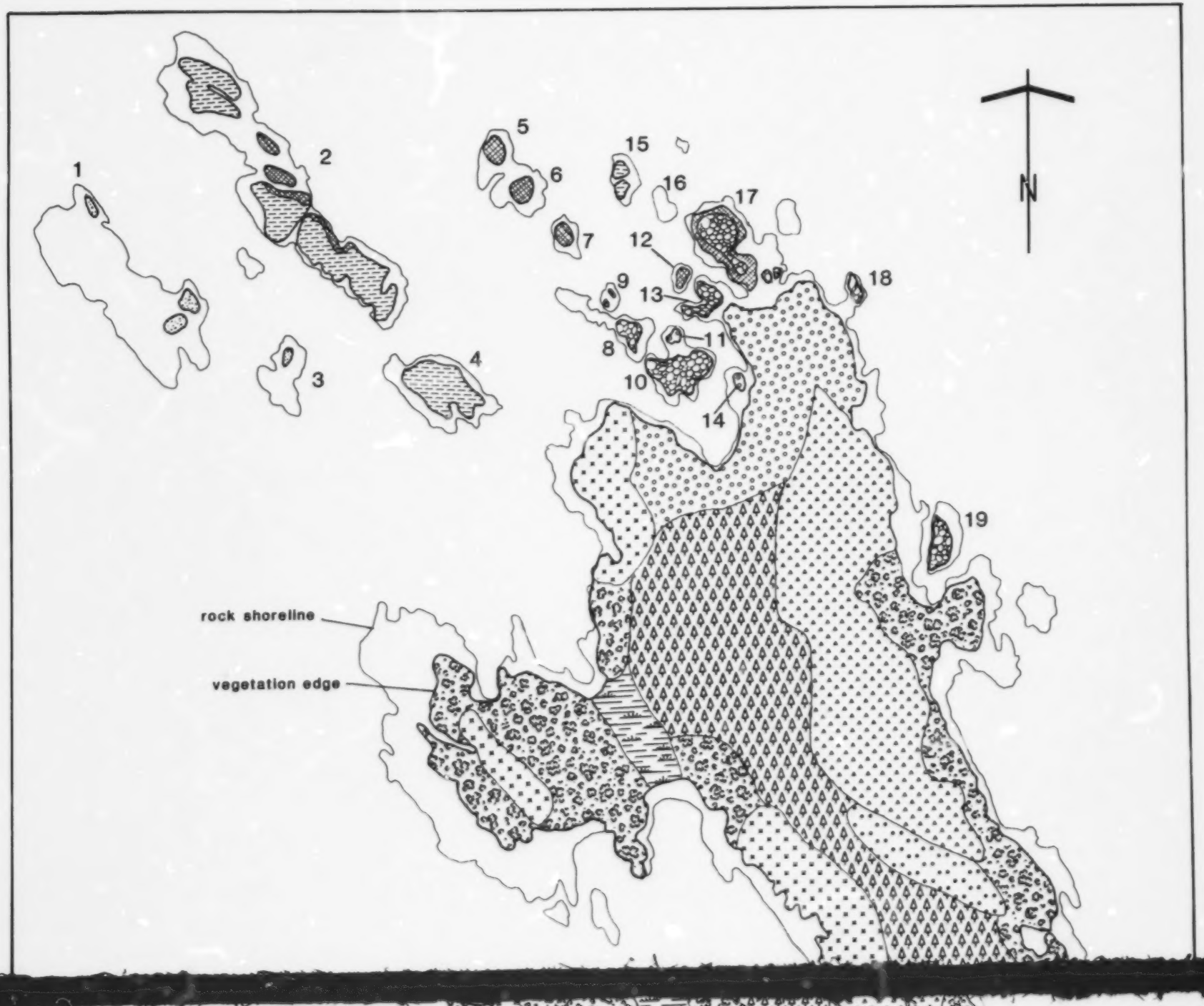


Figure WM280-1. Seabird colony areas and transect locations on Anthony Island in 1985.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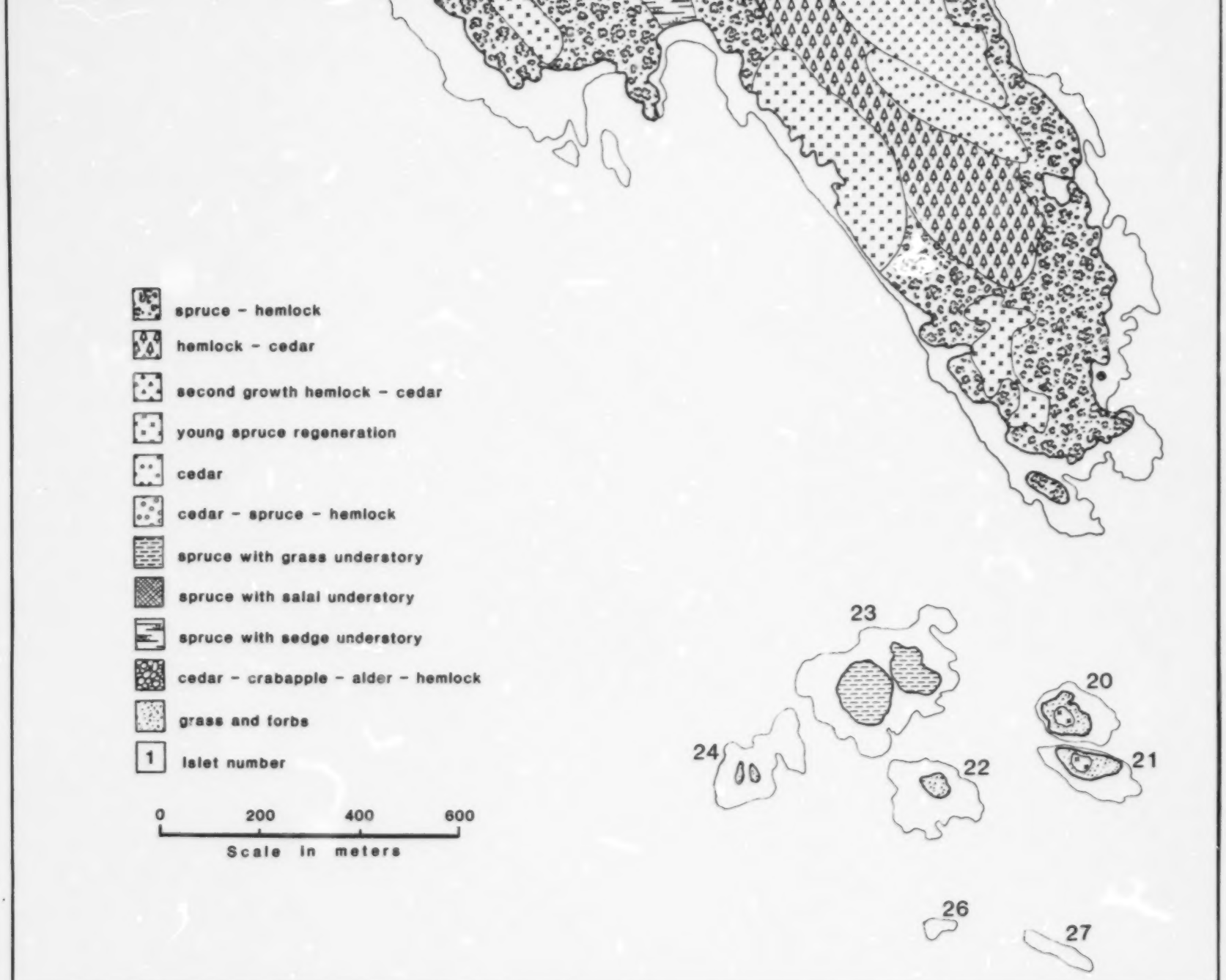

Figure WM280-2. Vegetation map of Anthony Island in 1985.

Table WM280-2 Extent of Cassin's Auklet and Rhinoceros Auklet colonies along transects on Anthony Island in 1985.

	Cassin's Auklet					Rhinoceros Auklet				
Tran	Dist. along transect (m)	Distance from nearest vegetation edge Min. (m)	Distance from nearest vegetation edge Max. (m)	Range of elevation (m)	Average slope (°)	Dist. along transect (m)	Distance from nearest vegetation edge Min. (m)	Distance from nearest vegetation edge Max. (m)	Range of elevation (m)	Average slope (°)
Northeast side main island										
1	0-11	0	11	10		0-11	0	11	10	
2	0-10	0	10	3	2	0-10	0	10	3	2
3	0-15	0	15	4-8	14	0-22	0	22	4-8	14
4	-					0-10	0	10	3	
5	-					0-33	0	33	10-12	14
6	-					0-29	0	29	5-10	30
7	-					0-45	0	45	10-20	21
8	-					0-78	0	78	2-28	17
9	-					0-90	0	90	10-40	17
10	-					0-40	0	55	5-35	12
11	-					0-85	0	90	15-25	14
12	-					0-65	0	65	2-20	11
13	-					0-37	0	37	5-10	16
14	-					0-15	0	15	9-11	15
Southwest side main island										
15	0-48	0	30	20-24	17	0-10	0	10	24	21
16	0-50	0	50	10-35	32	0-10	0	10	10-18	29
17	0-108	0	45	15-40	16	0-108	0	45	15-40	16
18	0-38	25	63	40-67	37	0-38	25	63	40-67	37
19	0-65	15	80	50-75	23	0-45	15	60	50-70	27
20	0-80	10	90	20-60	27	0-80	10	90	20-60	27
21	-					0-26	0	26	5-10	10
22	0-44	0	44	1-22	21	0-44	0	44	1-22	21
23	0-37	0	10	10-20	23	0-37	0	10	10-20	23
	53-147	5	60	2-30	24	53-147	5	60	2-30	24
24	0-52	0	10	13-18	13	0-52	0	10	13-18	13
25	0-50	0	10	25-33	26	0-50	0	10	25-33	26
26	0-46	0	15	20-30	25	-				

Table WM280-3. Habitat locations of Rhinoceros Auklet and Cassin's Auklet burrow entrances along transects on Anthony Island in 1985.

Location	Rhinoceros Auklet Northeast coast		Rhinoceros Auklet Southwest coast		Cassin's Auklet Southwest coast	
	Number	Percent	Number	Percent	Number	Percent
Tree base	5	6	2	2	1	1
Live tree roots	38	46	4	4	3	4
Stump	9	11	24	24	10	13
Dead tree roots	8	10	4	4	8	10
Log	7	8	17	17	6	8
Rock	4	5	1	1	5	6
Grass tussock	6	7	32	32	27	35
Open ground	2	2	4	4	2	3
Into bank	4	5	13	13	15	19
Totals	83		101		77	

Cassin's Auklet: continued

Number of sample plots:

Northeast side:	3 (27 m^2 - 0.9% of colony)
Southwest side:	55 (495 m^2 - 1% of colony)
Overall:	58 (522 m^2 - 1% of colony)

Average density:

Northeast side:	730 $\pm$ 370 burrows/ha (Table WM280-4)
Southwest side:	1550 $\pm$ 330 burrows/ha (Table WM280-5)

Colony area:

Northeast side:	0.3 ha
Southwest side:	4.8 ha
Southeast tip:	0.03 ha
Pockets on W & NW sides:	0.1 ha
Total:	5.3 ha

Total burrows:

Northeast side:	242 $\pm$ 122
Southwest side:	7439 $\pm$ 1584
Southeast tip:	19 (total count)
Pockets on W & NW sides:	259 (total count)
Total:	7959 $\pm$ 1588

Table WM280-4. Number of Cassin's Auklet burrows in 3x3 m plots along transects on the northeast side of Anthony Island in 1985. Plots considered outside the colony are indicated by a dash.

Plot	Transect					
	1	2	3	4	5	6
1	1	0	1	-	-	-
2	-	-	-	-	-	-
3					-	-

Table WM280-5. Number of Cassin's Auklet burrows in 3x3 m plots along transects on the southwest side of Anthony Island in 1985. Plots considered outside the colony are indicated by a dash.

Plot	Transect											
	15	16	17	18	19	20	21	22	23	24	25	26
1	1	0	1	0	2	1	-	0	2	0	0	12
2	0	6	3	0	1	2	-	1	0	1	5	3
3	0	1	3	0	0	4		1	0	0	3	1
4	6	0	0	-	0	0		-	-	0	3	-
5	1		1		1	0			0	-		
6	2		2			1			0			
7	-		6						0			
8			0						0			
9									0			
10									0			
11									-			

Rhinoceros Auklet: There were numerous, disjunct patches of burrowing by Rhinoceros Auklets around Anthony Island. One main area was on the east side, extending along the shore from the bay south of Ninstints to the small lake (Fig. WM280-1). Rhinoceros Auklets were nesting above the cliffs and shore rock and as far 90 m inland in this area. North of the village site on the east side we found burrows along the small ridges near shore. Burrowing was confined to within 30 m of the shore rock (Table WM280-2).

We found another major concentration of burrows along the slopes above the cliffs on the southwest side of the island and on separated knobs and ridges towards the south and west ends. Burrowing here extended from 0 to 90 m from shore (average width = 36 m), and from 1 to 70 m in elevation. The range of slope was 2 to 50°, and averaged 23° (Table WM280-2). Small, isolated patches of burrowing occurred around the north and south ends of the island.

Rhinoceros Auklets were nesting in association with Cassin's Auklets in many areas on the west side. The distribution of the two species presented interesting variations (see Cassin's Auklet account).

Rhinoceros Auklet burrows were located under tree roots, logs, grass tussocks, rocks, young regenerating spruce, and into the slope in mossy or bare areas (Table WM280-3). A greater proportion of burrows occurred under grass tussocks on the southwest side of the island probably due to the difference in ground vegetation cover on the two coasts of the island. Burrows extended as far as 20 m into thick, young spruce, though they were not as abundant and did not extend as far into it as Cassin's Auklet burrows.

Number of sample plots:

Northeast side:	43 (387 m^2 - 0.9% of colony)
Southwest side:	44 (396 m^2 - 0.9% of colony)
Overall:	87 (783 m^2 - 0.9% of colony)

Average density:

Northeast side:	2140 $\pm$ 410 burrows/ha (Table WM280-6)
Southwest side:	2520 $\pm$ 430 burrows/ha (Table WM280-7)

Colony area:

Northeast side:	4.4 ha
Southwest side:	4.3 ha
Pockets at N & S ends:	0.5 ha
Total:	9.2 ha

Total burrows:

Northeast side:	9354 $\pm$ 1792
Southwest side:	10,933 $\pm$ 1866
Southeast pockets:	164 (total counts)
Northwest pockets:	143 (total counts)
Total:	20,594 $\pm$ 2587

Table WM280-6. Number of Rhinoceros Auklet burrows in 3x3 m plots along transects on the northeast side of Anthony Island in 1985. Plots considered outside the colony are indicated by a dash.

Plot	Transect													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	0	1	4	1	3	2	4	5	9	4	6	3	0	9
2	-	-	0	-	1	1	7	0	0	2	1	0	1	-
3					0	-	2	0	3	0	1	1	0	
4							-	1	1	-	3	0	-	
5								1	0		5	0		
6								0	0		1			
7									-		-			

Table WM280-7. Number of Rhinoceros Auklet burrows in 3x3 m plots along transects on the southwest side of Anthony Island in 1985. Plots considered outside the colony are indicated by a dash.

Plot	Transect											
	15	16	17	18	19	20	21	22	23	24	25	26
1	3	4	6	0	6	6	10	1	9	2	1	-
2	-	-	4	0	4	4	1	2	2	3	1	-
3	-	-	2	2	0	1		1	0	3	0	-
4	-	-	0	-	-	0		-	-	0	0	-
5	-		1		-	0			4	-		
6	-		1			0			0			
7			1						2			
8			0						5			
9									7			
10									1			
11									-			

Tufted Puffin: Tufted Puffins appeared to be nesting at two locations on the main island: on the cliffs on the southwest side, and on the northwest point (Figure WM280-1). The maximum number seen around the southwest cliffs was 25 on 22 May 1985, and at the northwest corner was 3 on 17 June 1986. In 1986, we counted 24 birds at the southwest cliffs. No nest sites were accessible in these areas. Puffins were flying in and out of the steep grassy slope between the two deepest gorges on the southwest cliffs and on the steep slopes below transects 16 and 18, and appeared to be nesting in rock crevices on the northwest point. According to Dick Wilson, the warden at Ninstints in 1985, one pair had usually nested just north of the village site, but they were not seen in 1985. We suspect there are about 20 pairs nesting on the main island.

Predation: Very few depredated remains were found within surveyed plots along transect lines on the main island. Within the 116 plots surveyed (1044 m^2) only one Rhinoceros Auklet feather pile and one Fork-tailed Storm-Petrel feather pile were recorded. We did not attempt to estimate a predation rate from this data. Records of depredated remains found elsewhere on the island are presented in the summary section at the end of all the island accounts.

ISLETS SURROUNDING ANTHONY ISLAND (Figure WM280-1)

ISLET #1

Date of survey: 3 June (1945 h) and 4 June (1600 h) 1982. 29 May 1985 (1200-1230 h). 17 June (1245-1510 h) 1986.
Observers: 1982: M. Rodway, M. Lemon. 1985: M. Rodway. 1986: M. Rodway, D. Grinnell.

Census method: Exploration and total count.

Description: This outer northwest islet is mostly jagged rock pinnacles with two small vegetated areas: one grassy patch on the top of the pinnacle at the north end; and one low rock covered with grass (mostly Elymus) and forbs (Maianthemum, Angelica, Heracleum, Fritillaria, Montia, Castilleja) under a small stand of contorted, windswept spruce on the southeast corner. The total area of the islet is 6.0 ha, with 0.3 ha of vegetated habitat. There is a high-tide gravel beach adjacent to the southeast vegetated rock.

Nesting species:

Pelagic Cormorant: In 1982, there were 16 Pelagic Cormorant nests on this islet: 12 on the cliff faces on either side of the crevice between the main islet and the north pinnacle with the grassy patch, and 6 on the cliffs in the tidal chute at the south end. We determined the contents of 4 nests: 2 were empty, one contained 1 egg and one contained 4 eggs. There was one broken egg below the cliffs. Four nests had adults sitting on them, and the rest had birds standing beside them. 30 birds were roosting on the west side.

In 1985 and 1986, we saw no sign of cormorants nesting here.

Black Oystercatcher: In all three years there was a pair of oystercatchers on the beach area. In both 1985 and 1986, we found 1 nest with 2 eggs on the beach.

Glaucous-winged Gull: No nest counts were made in 1982 or 1985. At the time of our visit in 1982, most nests contained 3 eggs. In 1985, we counted 292 adults standing on territories. We saw 9 nest starts. We did a nest count in 1986 with the following results:

Start	Emp	1E	2E	3E	4E	2E1Y	1E2Y	1E1Y	3Y	2Y	1Y	TOTAL
4	16	3	21	171	4		4	1				224

We reached most of the area on this islet except two vertical slabs just north of the most southwest pinnacle. We estimated an additional 20 nests on these two sections, giving a total estimate of 244 nests for the islet.

Common Murre: In 1982, 3 murres flew off the inaccessible cliffs on the west side on both 3 June (1945 h) and 4 June (1600 h). We were unable to determine if they were nesting. We saw no sign of murres in 1985 or 1986.

Pigeon Guillemot: Pigeon Guillemots were nesting all around the Anthony Island group. Totals observed are listed in the species summary. In 1986, we counted 14 birds around islet #1. No nests were located.

Tufted Puffin: In 1982, Tufted Puffins were nesting on the northwest corner of this islet. We found 3 burrows in the grassy patch on the north pinnacle: 2 were empty and 1 contained a warm egg. Two other short burrows (15 cm) and 1 old burrow with an obstructed entrance were also found. A total of 8 adults were present, flying around this area (4 June 1300 h). We suspected some may have been nesting in rock crevices on the northwest pinnacles. In 1985, we saw 1 bird, and in 1986, there were 5 birds flying around the northwest corner. There were no burrows in the grassy area where they had previously been found. We suspected they were still nesting in rock crevices.

Horned Puffin: In 1982, there were 2 adults flying around the west side of islet #1 (3 June 1945 h). On 4 June 1600 h, we observed 1 adult fly into the top of a rock pinnacle on the west side. We saw no Horned Puffins in 1985 or 1986.

ISLET #2

Date of survey: 26 and 27 May 1985. 17 June 1986 (1530 h).

Observers: 1985: M. Lemon, D. Garnier, D. Power. 1986: M. Rodway, D. Grinnell.

Census method: Line transects: 22 plots (3x3 m) along 4 transects (storm-petrel, Cassin's Auklet, Rhinoceros Auklet) (Table WM280-1). Partial count (Rhinoceros Auklet).

Description: This is an 8.0 ha islet with 4.3 ha of vegetated area. Rock fissures cut the islet into a number of steep-sided segments. The vegetation is mostly grass (Calamagrostis with Elymus in perimeter areas) under spruce. There are some mossy areas, and seedling spruce are scattered over much of the islet. Dense salal grows along the edges and towards the interior of the middle section of knolls, especially on the east side.

Nesting species:

Storm-petrel: Storm-petrels were burrowing through most vegetated habitat (Table WM280-8) except under the thickest and tallest salal. They were most abundant over the southern two-thirds of the islet. Most burrow entrances were located under logs, in open ground, under stumps, live tree roots, or grass tussocks (Table WM280-9). Two burrows contained single adult Fork-tailed Storm-Petrels (one in a burrow outside the plots), and one burrow explored was empty (Table WM280-17).

Number of sample plots: 17 (153 m^2 - 0.4% of colony)

Average Density: 973 $\pm$ 298 burrows/ha (Table WM280-10)

Colony Area: 3.7 ha

Total Burrows: 3551 $\pm$ 1088

Black Oystercatcher: In 1986, we found 2 empty scrapes on the rock along the southwest side of the islet. Two adults were present.

Cassin's Auklet: Cassin's Auklets were burrowing in all vegetated areas except under the thickest salal (Table WM280-8). Most burrows were located into banks, under grass tussocks, logs, or live tree roots (Table WM280-9).

Number of sample plots: 19 (171 m^2 - 0.4% of colony)

Average Density: 3510 $\pm$ 830 burrows/ha (Table WM280-11)

Colony Area: 4.0 ha

Total Burrows: 14,040 $\pm$ 3320

Table WM280-8 Extent of storm-petrel, Cassin's Auklet and Rhinoceros Auklet colonies on Islets #2 and #4 [Anthony Island area] in 1985.

Transect	Storm-petrel					Cassin's Auklet					Rhinoceros Auklet				
	Dist. along transect (m)	Dist. from nearest vegetation edge Min. (m)	Max. (m)	Range of elevation (m)	Average slope (°)	Dist. along transect (m)	Dist. from nearest vegetation edge Min. (m)	Max. (m)	Range of elevation (m)	Average slope (°)	Dist. along transect (m)	Dist. from nearest vegetation edge Min. (m)	Max. (m)	Range of elevation (m)	Average slope (°)
Islet #2															
1	0-51	0	21	10-15	22	0-51	0	21	10-15	22	-				
2	0-95	0	45	10-25	21	0-95	0	45	10-25	21	-				
3	-					0-67	0	32	15-20	20	0-67	0	32	15-20	20
4	0-90	0	37	15-20	22	0-30	0	30	10-20	21	-				
						74-90	0	10	10-20	16	80-90	0	10	15	16
Islet #4															
1	0-110	0	50	15-20	15	0-27	0	27	15-20	5	-				
						57-110	0	45	15-20	20					

Table WM280-9. Habitat locations of Cassin's Auklets and storm-petrel burrow entrances along transects on islets surrounding Anthony Island, in 1985.

	Cassin's Auklet		Storm-petrels	
	Number	Percent	Number	Percent
Tree base	3	2	1	2
Live tree roots	13	10	7	12
Stump	4	3	8	14
Dead tree roots	7	5	2	3
Log	21	16	16	28
Grass tussocks	36	27	6	10
Open ground	11	8	10	17
Into bank	38	28	5	9
Shrubbery	2	1	3	5
Totals	135		58	

Table WM280-10. Number of storm-petrel burrows in 3x3 m plots along transects on Islet #2 [Anthony Island area] in 1985. Plots considered outside the colony are indicated by a dash.

Transect	Plots						
	1	2	3	4	5	6	7
1	0	0	1	0			
2	0	0	3	1	1	1	1
3	-	-	-	-	-		
4	0	1	0	1	4	1	

Table WM280-11. Number of Cassin's Auklet burrows in 3x3 m plots along transects on Islet #2 [Anthony Island area] in 1985. Plots considered outside the colony are indicated by a dash.

Transect	Plots						
	1	2	3	4	5	6	7
1	7	8	3	0			
2	1	0	0	1	2	5	0
3	12	2	1	3	5		
4	6	2	-	-	-	2	

Rhinoceros Auklet: Rhinoceros Auklet burrows were scattered around the perimeter of the islet.

Number of sample plots: 6 (54 m^2 - 0.7%)

Average Density: 370 burrows/ha (only 2 burrows were found in the 6 plots surveyed in the Rhinoceros Auklet nesting areas. No standard error was calculated) (Table WM280-12).

Colony Area: 0.8 ha

Total Burrows: 289

Table WM280-12. Number Rhinoceros Auklet burrows in 3x3 m plots along transects on Islet #2 [Anthony Island area] in 1985. Plots considered outside the colony are indicated by a dash.

Transect	Plots						
	1	2	3	4	5	6	7
1	-	-	-	-			
2	-	-	-	-	-	-	-
3	0	0	0	0	2		
4	-	-	-	-	-	0	

Predation: Within the plots along the transects we found one feather pile of a Fork-tailed Storm-Petrel and three feather piles of Cassin's Auklets. There were 4 Bald Eagle nests on the islet, probably belonging to one pair of eagles. Bald Eagle pellets containing feathers were found.

ISLET #3

Date of survey: 28 May (1700-1715 h) and 29 May (1200-1230 h) 1985. 17 June 1986 (1545-1610 h).

Observers: 1985: D. Power. 1986: D. Grinnell, M. Rodway.

Census method: Total count.

Description: This 0.9 ha islet is mostly bare rock with a 0.1 ha grassy (Calamagrostis) area on the higher knob on the east end. There are a few small spruce trees and snags on this knob.

Nesting species:

Storm-petrel: In 1985, 4 burrows were counted around the west side of the grassy area. No contents were determined.

Black Oystercatcher: In 1985, we found 1 nest with 2 eggs. The nest was on bare rock made of rock chips and one piece of sea urchin shell. There was no sign of nesting on this islet in 1986.

Glaucous-winged Gull: At the time of our survey in 1985, there were 16 adults on territories. In 1986, we counted the following nests:

Start	Emp	1E	2E	3E	4E	2E1Y	1E2Y	1E1Y	3Y	2Y	1Y	TOTAL
	1			10								11

Nests were made of grass. One nest of 3 eggs contained one pale blue-green egg with few spots.

Pigeon Guillemot: There were 5 birds along the north side of this islet in 1986.

Cassin's Auklet: We counted 65 burrows in 1985. No contents were determined, but burrows appeared active with droppings and regurgitated food at their entrances.

Rhinoceros Auklet: Three larger burrows were suspected to be Rhinoceros Auklet burrows. One had droppings at the entrance.

ISLET #4

Date of survey: 29 May 1985.

Observers: M. Lemon, D. Garnier.

Census method: 7 quadrats (3x3 m) along 1 transect (Table WM280-1)

Description: This is a 2.2 ha islet with 1.3 ha of vegetated habitat. The islet is similar to islet #2, with steep sides and dissecting rock fissures. Most of the vegetated area is covered with thick grass (Calamagrostis) under an open spruce forest. There are some mossy areas and patches of seedling spruce.

Nesting species:

Storm-petrel: Burrows occurred throughout (Table WM280-8) under grass, roots and into open ground. One Fork-tailed Storm-Petrel was heard calling from a burrow, and a pair of Leach's Storm-Petrels were found in another. Six other burrows explored were empty (Table WM280-17). Since it was early in the season, they may have belonged to Leach's Storm-Petrels.

Number of sample plots: 7 (63 m^2 - 0.5% of colony)

Average Density: 3800 $\pm$ 640 burrows/ha (Table WM280-13)

Colony Area: 1.3 ha

Total Burrows: 4940 $\pm$ 832

Cassin's Auklet: Burrowing occurred over most of the vegetated area, except the central portion of the island (Table WM280-8) under grass, roots and into open ground.

Number of sample plots: 5 (45 m^2 - 0.4% of colony)

Average Density: 1320 $\pm$ 539 burrows/ha (Table WM280-13)

Colony Area: 1.1 ha

Total Burrows: 1386 $\pm$ 566

Predation: No remains were found within the plots along the transect.

ISLET #5

Date of survey: 28 May 1985 (1600-1700 h).

Observers: M. Rodway, D. Power.

Census method: Six 1 m wide and 25 m long strip transects. Transects were evenly spaced around the perimeter of the island, and run from shore to the middle of the island.

Description: This is a 0.6 ha islet, with 0.2 ha of open spruce forest. The ground cover is about 70% salal, with the rest grass, some moss, and Maianthemum.

Table WM280-13. Number of storm-petrel and Cassin's Auklet burrows in 3x3 m plots along transects on Islets #4, 15, 20 and 21 [Anthony Island area] in 1985. Plots considered outside the colony are indicated by a dash.

Islet and Species	Plots						
	1	2	3	4	5	6	7
Islet #4							
Storm-petrel	2	2	4	2	4	4	6
Cassin's Auklet	0	2	-	-	2	0	2
Islet #15							
Storm-petrel	10	5	0				
Cassin's Auklet	3	6	2				
Islet #20							
Storm-petrel	2	0	1	1	0	0	
Cassin's Auklet	3	1	1	0	0	2	
Islet #21							
Storm-petrel	-	-	-	-			
Cassin's Auklet	8	3	6	0			

Nesting species:

Storm-petrel: Storm-petrel burrows were found in grassy areas and under salal right across the islet.

Average Density: A total of 21 burrows were counted in the 150 m^2 area surveyed along the transects (individual strips had 0,7,5,5,0 and 4 burrows), giving a density of 0.14 burrows/m^2 (1400 burrows/ha).

Colony Area: 0.2 ha

Total Burrows: 280

Pigeon Guillemot: Pigeon Guillemots were nesting in burrows at the edge of the vegetation. One adult with two eggs was found in a 0.3 m long burrow under Maianthemum at the edge of the rocks. We estimated 10 burrows around the islet.

Cassin's Auklet: Burrows were located within 6 m of the edge of the vegetation in grassy areas and under the edge of the salal.

Average Density: Individual strips had 8,3,1,1,2,0 and 11 burrows, for a total of 44 burrows counted on the 6 transects, giving an average density of 0.29 burrows/m^2 (2900 burrows/ha).

Colony Area: 0.1 ha

Total Burrows: 580 (density was calculated for the whole islet, so it was multiplied by the entire vegetated area).

ISLET #6

Date of survey: 28 May 1985 (1500-1600 h).

Observers: M. Rodway, D. Power.

Census method: Six 1 m wide by 22 m long strip transects. Transects were evenly spaced around the perimeter of the island, and run from the perimeter to the middle of the island.

Description: This 0.9 ha islet has 0.15 ha of vegetated habitat. Most of the vegetated area is covered with salal under spruce (average dbh = 0.6 m). Grass and patches of spruce seedlings occur around the fringes.

Nesting species:

Storm-petrel: Storm-petrel burrows were most abundant near the outer edges in the grass and under the salal, but did occur under the salal to the high point of the islet. We found one petrel burrow that had been dug open, and Fork-tailed Storm-Petrel wings and feathers were scattered nearby.

Average Density: We counted a total of 92 petrel burrows in the 132 m^2 surveyed along the 6 transects (in the individual strips there were 26,9,13,21,7 and 16 burrows), giving an average density of 0.70 burrows/m^2 (7000 burrows/ha).

Colony Area: 0.15 ha

Total Burrows: 1045

Cassin's Auklet: Cassin's Auklets were burrowing in the grassy perimeter areas and under the edges of the salal, usually within 5 m of the vegetation edge.

Average Density: We counted 48 burrows on the 6 transects, giving an overall density for the island of 0.36 burrows/m^2 (3600 burrows/ha). (In individual strips there were 0,2,4,10,8 and 24 burrows.)

Colony Area: 0.07 ha

Total Burrows: 545 (As density was calculated for the whole island, we used the total vegetated area in our calculation of total burrows).

Rhinoceros Auklet: We found a few Rhinoceros Auklet burrows at the edge of the vegetation. We estimated there were no more than 10 burrows. Burrows had droppings at their entrances.

ISLET #7

Date of survey: 28 May 1985 (1400-1500 h).

Observers: M. Rodway, D. Power.

Census method: Total count for Cassin's and Rhinoceros Auklets. Partial count plus two 1 m wide by 15 m long strip transects through the salal on the south west side for storm-petrels.

Description: Most of the 0.1 ha of vegetated area on this 0.4 ha islet is covered with salal under spruce. Some of the salal has been severely browsed by the deer to less than 0.5 m high, especially around the northwest corner, where some areas have been wind-pruned to the same height. Grass occurs on the fringes to as far as 5 m from the shore rock. A few spruce seedlings and some salmonberry occur on the edges.

Nesting species:

Storm-petrel: Most petrel burrows were in the areas of browsed salal on the northwest corner. They were in the grass around the edges, and on the west side they also extended through thick, 1.5 m tall salal to the crest of the island. We did not find them in the high salal on the east side.

Colony Area: 0.08 ha

Total Burrows: We counted 75 burrows around the perimeter of the islet. The two transects sampled a 10 m by 15 m area of salal, and contained 16 and 17 burrows each, giving a total estimate for the islet of 235 burrows.

Cassin's Auklet: Cassin's Auklet burrows were located in grass and under the edges of the salal. They extended as far as 10 m from the edge of the vegetation in areas of browsed salal.

Colony Area: 0.05 ha

Total Burrows: 270.

Rhinoceros Auklet: We counted 8 burrows around the perimeter. A few extended as far as 10 m from the edge in the areas of browsed salal. There were droppings and feathers at their entrances.

ISLET #8

Date of survey: 26 May 1985.

Observers: M. Rodway.

Census method: Total count.

Description: The 1.0 ha islet is a series of vegetated knobs connected by high tidal, or above-tide rock. The 0.25 ha of vegetated area is mostly windswept salal under spruce, with some crabapple, Sitka Alder and redcedar shrub. The main southeastern knob has an open mossy center under contorted redcedars and crabapples, with heavily browsed salal under small spruce around the perimeter. There were river otter runs on the northwest end of the main knob.

Nesting species:

Cassin's Auklet: We counted 24 burrows on the southwest side of the main knob. Most were within 1 m of the edge under salal and tree roots, and in rock crevices. Some extended as far as 4 m from the edge.

Rhinoceros Auklet: There were 3 Rhinoceros Auklet burrows in the same area as the Cassin's Auklets.

ISLET #9

Date of survey: 26 May 1985.

Observers: M. Rodway.

Census method: Total count.

Description: This small 0.2 ha islet is barely connected to islet #8 at low tide. Most of the 400 m^2 of vegetation is windswept salal under spruce. Crabapple occurs in the center and there is some shrub redcedar on the south west side.

Nesting species:

Cassin's Auklet: Nine burrows were counted within 2 m of the edge along the northeast (8) and southwest (1) sides. Burrows had fecal streaking and regurgitated food at the entrances.

ISLET #10

Date of survey: 26 May 1985.

Observers: M. Rodway.

Census method: Total count.

Description: This 1.1 ha islet is connected with islets #8 and #11 by low tidal rock and gravel bars. The islet consists of raised knobs separated by an open meadow-like area across the middle. Salal is thick around the edges but has been heavily browsed towards the interior, which is mossy or bare under a forest of redcedar, hemlock, spruce, Sitka Alder and crabapple. The total vegetated area is 0.9 ha. River otter runs were abundant on the south corner, and deer traffic was heavy throughout.

Nesting species:

Cassin's Auklet: There was 1 burrow on the southwest side.

Rhinoceros Auklet: There were 2 large burrows on the southwest side.

ISLET #11

Date of survey: 26 May 1985.

Observers: M. Rodway.

Census method: Total count.

Description: This 0.2 ha islet has 0.1 ha of salal under spruce, hemlock and windswept redcedar.

Nesting species:

Cassin's Auklet: There was 1 burrow on the west side.

Rhinoceros Auklet: One old burrow was found on the north corner.

ISLET #12

Date of survey: 26 May 1985.

Observers: M. Rodway.

Census method: Total count.

Description: There is 0.15 ha of vegetated habitat on this 0.2 ha islet. It is almost solid salal under spruce, with small mossy areas within 1 m of the shore rock.

Nesting species:

Cassin's Auklet: Fifty-four burrows were counted around the islet, mostly on the north and northwest sides under the edge of the salal, tree roots, and in the small mossy areas. Most burrow entrances were streaked with fecal droppings.

Rhinoceros Auklet: There was 1 large burrow with Rhinoceros Auklet droppings at the entrance.

ISLET #13

Date of survey: 26 May 1985.

Observers: M. Rodway.

Census method: Total count.

Description: The 0.5 ha of this islet is comprised of two knobs connected by a low tidal area to the main island. The 0.35 ha of vegetation consists of thick salal around the perimeter, opening to mossy and bare areas in the interior under redcedar, hemlock and Sitka Alder, with scattered crabapple, copperbush (Cladothamnus pyrolaeflorus) and huckleberry. The interior edges of the salal have been heavily browsed by deer. There were river otter runs on the northwest end.

Nesting species:

Rhinoceros Auklet: One burrow on the west corner.

ISLET #14

Date of survey: 26 May 1985.

Observers: M. Rodway.

Census method: Exploration.

Description: This 0.2 ha islet is connected to the beach of the main island. Almost all the area is vegetated, and is mostly bare litter under small redcedar and a few hemlock. There are some mossy patches and fringes of salal.

Nesting species: There were no burrows.

ISLET #15

Date of survey: 26, 28 May 1985.

Observers: M. Rodway, D.Power.

Census method: 3 quadrats (3x3 m) along 1 transect (Table WM280-1)

Description: This 0.4 ha islet is bissected by a crevice into a larger northern section and a smaller southern section. The 0.2 ha of vegetated habitat is about 70% grass (mostly Calamagrostis with Elymus on the edges) and 30% salal under a spruce forest. Some of the salal has been severely browsed, creating bare areas amongst dwarfed and dead stalks.

Nesting species:

Storm-petrel: Storm-petrels were burrowing around the grassy edges as well as throughout the areas of heavily browsed salal (<30 cm) where they were most abundant. No petrel burrows were found in the interior grassy areas. One burrow explored contained a pair of Fork-tailed Storm-Petrels, one contained a Leach's Storm-Petrel, and one burrow was empty (Table WM280-17).

Average Density: There were 15 petrel burrows in the 3 plots surveyed (Table WM280-13), giving an overall density estimate of 0.56 $\pm$ 0.32 burrows/m^2 (5600 $\pm$ 3200 burrows/ha). Density was higher in the areas of browsed salal.

Colony Area: 0.1 ha (We estimated that half of the habitat was being used).

Total Burrows: 1120 $\pm$ 640 (As density was estimated for the entire area, it was used to calculate burrow numbers).

Cassin's Auklet: Cassin's Auklets were burrowing around the perimeter and only sporadically in the interior grassy areas.

Average Density: We counted 11 burrows in the 3 plots surveyed giving a density estimate of 0.41 $\pm$ 0.14 burrows/m^2 (4100 $\pm$ 1400 burrows/ha) (Table WM280-13).

Colony Area: 0.1 ha (We estimated that half the area was being used).

Total Burrows: 820 $\pm$ 280 (see storm-petrels).

Predation: No depredated remains were found within the plots.

ISLET #16

Date of survey: 26 May 1985. 17 June 1986.

Observers: 1985: M. Rodway. 1986: D. Garnier.

Census method: Total count.

Description: This is a low-lying 0.2 ha rock with small tufts of Potentilla and Saxifraga.

Nesting species:

Black Oystercatcher: In 1985, we found 2 empty scrapes made of shells. There were 4 adults present. In 1986, there was 1 nest with 3 eggs and 1 empty nest. Nests were worn dirt bowls with some shells. Two adults were present.

ISLET #17

Date of survey: 26 May 1985.

Observers: M. Rodway.

Census method: Total count.

Description: This 2.1 ha islet consists of a large northern knob plus a few smaller knobs that are connected to the main islet by a tidal beach. The knobs are covered with salal under spruce around the perimeters, with open mossy or bare litter areas in the interior under crabapple, redcedar, hemlock, Sitka Alder and spruce. In some areas there are piles of dead salal stalks and plants dwarfed by deer browsing. There is 1.4 ha of vegetated habitat.

Nesting species:

Cassin's Auklet: We counted 278 Cassin's Auklet burrows around the perimeter of the northern knob. Burrows were under salal, tree roots and rock in open mossy areas within 15 m of the shore rock on the east side, and within 5 m or less around the rest of the knob. Most burrows were streaked with fecal droppings and regurgitated food.

Rhinoceros Auklet: Rhinoceros Auklet burrows were scattered in the same areas as Cassin's Auklets. We counted 18 burrows, with fecal droppings noted at the entrances to some burrows.

Predation: A few river otter scats contained some feathers, but were mostly composed of fish remains.

ISLET #18

Date of survey: 27 May 1985.

Observers: D. Garnier.

Census method: Total count.

Description: This steep-sided 0.2 ha islet is connected at low tide to the main island. The entire area above the steep rocky sides is vegetated. The northwest third of the islet is covered with thick salal under spruce, and the rest is grass and moss under spruce, crabapple and hemlock.

Nesting species:

Cassin's Auklet: We counted 105 Cassin's Auklet burrows along the southeast and northeast sides. Burrows were under roots in open mossy areas around the edges as well as under salal and in crevices. Most burrows were within 5 m of the vegetation edge, but some occurred as far as 15 m from the edge in narrow gullies.

Rhinoceros Auklet: The distribution of Rhinoceros Auklet burrows was the same as Cassin's Auklets. We counted 87 burrows.

ISLET #19

Date of survey: 1 June 1985.

Observers: M. Lemon, M. Rodway.

Census method: Exploration.

Description: This 0.8 ha islet shelters the village bay of Ninstints and is connected to the main island shore at low tide. There are small rock bluffs on the south and west sides. It has 0.4 ha of vegetation, most of which is grassy under spruce (0.5 m dbh), with some bare litter and mossy interior areas under crabapple and hemlock. There are a few redcedar and Sitka Alder on the west side, and salal overhangs the small cliffs there.

Nesting species:

Fork-tailed Storm-Petrel: Fork-tailed Storm-Petrels were heard calling at night around this islet (0115 h 3 June 1982, and 2300 h 24 May 1985) but no sign of nesting was found on a thorough search.

Pigeon Guillemot: Pigeon Guillemots were seen flying into burrows on the edge of the vegetation above the small cliffs on the south side. Two nest sites were visible below. We suspected 2 pairs nesting.

ISLET #20

Date of survey: 29 May 1985.

Observers: M. Lemon, D. Garnier.

Census method: 6 quadrats (3x3 m) on 1 transect (Table WM280-1).

Description: This 1.5 ha islet off the southeast corner of the main island is steep-sided with undulating ridges and knolls on the top. A major, central portion of the 0.5 ha of vegetated habitat is covered with dense regenerating

spruce, 3-4 m tall. Only a few large spruce and spruce snags remain standing. Around the perimeter of the young spruce are areas of grass (Calamagrostis) and forbs. The islet is separated from islet #21 by a narrow channel of water.

Nesting species:

Storm-petrel: Storm-petrels were nesting in small numbers over much of the islet under grass tussocks and logs.

Number of sample plots: 6 (54 m^2 - 1% of colony

Average Density: 730 $\pm$ 360 burrows/ha (Table WM280-13)

Colony Area: 0.5 ha

Total Burrows: 365 $\pm$ 180

Cassin's Auklet: Cassin's Auklet burrows were continuous over the islet under grass tussocks, tree roots and logs. Density was highest on the periphery.

Number of sample plots: 6 (54 m^2 - 1% of colony)

Average Density: 1280 $\pm$ 520 burrows/ha (Table WM280-13)

Colony Area: 0.5 ha

Total Burrows: 640 $\pm$ 260

Rhinoceros Auklet: We saw a few Rhinoceros Auklet burrows amongst the Cassin's Auklets on the west end of the islet. We estimated a total of 20.

Predation: No depredated remains were found within the plots. There were river otter runs on the east side with scats of fish.

ISLET #21

Date of survey: 29 May 1985.

Observers: M. Rodway, D. Power.

Census method: 4 quadrats (3x3 m) on 1 transect (Table WM280-1)

Description: The islet is steep-sided, especially on the north and south sides, and is stepped higher on the west end. It has a total area of 1.4 ha, with 0.5 ha of vegetation. The lower east portion is grassy with patches of moss and forbs under spruce. The middle of the west section is covered with thick young spruce, 3-5 m tall, surrounded by a perimeter of grass. The

eastern part of the island has some large standing spruce snags.

Nesting species:

Storm-petrel: Storm-petrels were sparsely nesting. No petrel burrows were encountered in the surveyed plots, but we found 2 just outside of the plot on the north side. We suspect there were no more than 100 petrel burrows on the island.

Cassin's Auklet: Cassin's Auklets were nesting over most of the islet, most abundantly in the eastern grass and forb habitat, and only sparsely under the young spruce. Little burrowing occurred on the steep grassy slope on the north side as the soil was thin.

Number of sample plots: 4 (36 m^2 - 0.7% of colony)

Average Density: 4730 $\pm$ 1951 burrows/ha (Table WM280-13)

Colony Area: 0.5 ha

Total Burrows: 2365 $\pm$ 975

Rhinoceros Auklet: No definite Rhinoceros Auklet burrows were found. Some burrows had larger entrances but they all appeared to taper in the tunnels to typical Cassin's Auklet size.

Predation: No depredated remains were found within the plots, but the entrances of 3 Cassin's Auklet burrows in the plots had been dug open.

ISLET #22

Date of survey: 4 June 1985 (1100-1200 h). 16 June 1986 (1700-1800 h).

Observers: 1985: D. Garnier, D. Power. 1986: M. Rodway, D. Garnier, D. Grinnell.

Census method: Total count.

Description: This 2.2 ha, low rock has many undulating, dissected ridges and crevices. In a depression in the top middle is a clump of windswept spruce, surrounded by higher areas of Elymus, Angelica, and Maianthemum.

Nesting species:

Black Oystercatcher: In 1985, we found 5 nests: 3 with 2 eggs, and 2 with 3 eggs. Nests were made of mussel and limpet shells, and some grass. In 1986, we found 3 nests: 1 with 1 egg, and 2 with 3 young. There were 4 adults present.

Glaucous-winged Gull: In 1985, we counted 44 nests, only 6 of which had eggs: 5 with 1 egg, and 1 with 3 eggs. In 1986, the following nests were tallied:

Start	Emp	1E	2E	3E	4E	2E1Y	1E2Y	1E1Y	3Y	2Y	1Y	TOTAL
4	1	1	6	32								44

Nests were made of grass, Cochlearia and Achillea.

Pigeon Guillemot: In 1985, there were 37 Pigeon Guillemots on the rocks on the southeast side. In 1986, we found 3 nests with 2 eggs. There were 8 adults around the shore.

ISLET #23

Date of survey: 27 May 1985 (1550-1800 h).

Observers: M. Lemon, M. Rodway, D. Garnier, D. Power.

Census method: 16 quadrats (3x3 m) along 2 transects (Table WM280-1)

Description: The 5.8 ha of this low, undulating islet is comprised mostly of extensive rocky shores, surrounding 1.75 ha of grass (Calamagrostis) and forbs under an open spruce forest. A number of large snags are standing or have fallen in the grass.

Nesting species:

Storm-Petrel: No petrel burrows were encountered in our surveyed plots, but we heard one Fork-tailed Storm-Petrel calling from a burrow. We estimated that there were no more than 100 petrel burrows on the islet. Leach's Storm-Petrels may also have been present.

Cassin's Auklet: We found Cassin's Auklet burrows throughout the vegetated area under grass tusssocks, tree roots, and in open ground. Burrow density was highest on the perimeter.

Number of sample plots: 16 (144 m^2 - 0.8% of colony)

Average Density: 2430 $\pm$ 830 burrows/ha (Table WM280-14)

Colony Area: 1.75 ha

Total Burrows: 4253 $\pm$ 1453

Table WM280-14. Number of Cassin's Auklet burrows in 3x3 m plots transects on Islet #23 [Anthony Island area] in 1985.

Transect	Plots								
	1	2	3	4	5	6	7	8	9
1	5	0	2	2	2	0	1	0	1
2	5	0	0	0	5	1	11		

Rhinoceros Auklet: Rhinoceros Auklet burrows were scattered throughout, but were much less abundant than Cassin's Auklets.

Number of sample plots: 16 (144 m^2 - 0.8% of colony)

Average Density: 275 $\pm$ 213 burrows/ha (Table WM280-15)

Colony Area: 1.75 ha

Total Burrows: 481 $\pm$ 373

Table WM280-15. Number of Rhinoceros Auklet burrows in 3x3 m plots along transects on Islet #23 [Anthony Island area] in 1985.

Transect	Plots								
	1	2	3	4	5	6	7	8	9
1	0	3	0	0	0	0	0	0	0
2	0	0	0	0	0	0	1		

Predation: We found 1 Rhinoceros Auklet feather pile within the plots along the transects. Some scats observed near a river otter den and runs contained feathers.

ISLET #24

Date of survey: 17 June 1986 (1800-1840 h).

Observers: M. Rodway, D. Garnier, D. Grinnell.

Census method: Total count.

Description: This 1.9 ha islet is mostly bare rock, with two patches of Elymus on top.

Nesting species:

Black Oystercatcher: There were 3 adults on the islet, but no nests were found.

Glaucous-winged Gull: We counted the following nests:

Start	Emp	1E	2E	3E	4E	2E1Y	1E2Y	1E1Y	3Y	2Y	1Y	TOTAL
1	1	1	1	14								18

Pigeon Guillemot: There were 10 adults on the rocks.

Cassin's Auklet: We found 33 Cassin's Auklet burrows in the two patches of Elymus. One incubating adult was pulled from a burrow.

Tufted Puffin: There were 5 very large burrows in the grass on this islet. No puffins were seen in the vicinity and no burrow contents were determined.

ISLET #25

Date of survey: 17 June 1986.

Observers: M. Rodway, D. Garnier, D. Grinnell.

Census method: Total count.

Description: This outer southwest rock is a light coloured, eroded, granite, with an area of 1.2 ha. It is a sea-lion haul-out (see Associated species). The small 37' rock off the west side of this islet is bare and had no birds around it.

Nesting species:

Black Oystercatcher: We found 1 nest with 1 egg. Two adults were present.

Glaucous-winged Gull: The following nests were recorded:

Start Emp	1E	2E	3E	4E	2E1Y	1E2Y	1E1Y	3Y	2Y	1Y	TOTAL
	3	3	19								25

A total of 51 adults were counted.

Pigeon Guillemot: Three adults were on the water around the islet.

ISLET #26

Date of survey: 17 June 1986 (1840-1850 h).

Observers: M. Rodway.

Census method: Total count.

Description: This is a small bare rock, less than 0.25 ha in size.

Nesting species:

Glaucous-winged Gull: There was 1 nest with 3 eggs.

ISLET #27

Date of survey: 17 June 1986 (1855-1905 h).

Observers: M. Rodway.

Census method: Total count.

Description: This is a bare 10 m high rock, less than 0.25 ha in size.

Nesting species:

Black Oystercatcher: We found 1 nest with 3 eggs. It was made of rock chips and attended by 2 adults.

Glaucous-winged Gull: There were 3 nests: 1 with 1 egg, 1 with 2 eggs, and 1 with 3 eggs. Nests were made of grass mixed with seaweed.

SUMMARY OF SEABIRD NESTING POPULATIONS ON ANTHONY ISLAND AND SURROUNDING ISLETS

Fork-tailed and Leach's Storm-Petrel: Storm-petrels were nesting only on the smaller islets surrounding Anthony Island (Table WM280-16). Their nesting habitat on these islets included grass, moss or bare litter areas, and salal under open spruce forest. They were burrowing under very thick, tall salal, and were abundant in patches of salal that had been severely dwarfed by browsing deer. The mean length of a sample of 11 burrows was 52 ± 7 cm.

Table WM280-16. Summary of storm-petrel colony area and burrow numbers on Anthony Island and the surrounding islets in 1985.

Islet	Average density (burrows/ha)	Number of sample plots	Colony area (ha)	Total burrows
2	973 ± 298	17	3.7	3551 ± 1088
3			t	4
4	3800 ± 640	7	1.3	4940 ± 832
5			0.2	280
6			0.15	1045
7			0.08	235
15	5600 ± 3200	3	0.1	1120 ± 640
20	730 ± 360	6	0.5	365 ± 180
21			0.1	100
23			0.1	100
Overall	1894 ± 245	33	6.2	11,740 ± 1522

t: trace

No occupancy rate was determined for storm-petrels as our survey occurred too early to obtain a reliable proportion and rate for Leach's Storm-Petrels. Both Fork-tailed and Leach's storm-petrels were found in burrows (Table WM280-17). Using the B.C. median storm-petrel occupancy rate of 91%, and the proportion of Fork-tailed Storm-Petrels determined within quadrats (2 out of 14), we estimated nesting populations on the Anthony Island group, of 2096 ± 272 pairs of Fork-tailed Storm-Petrels and 8587 ± 1113 pairs of Leach's Storm-Petrels.

Table WM280-17. Occupancy of storm-petrel burrows in 3x3 m plots along transects on islets surrounding Anthony Island in 1985.

Date	Location			Contents					
	Islet	Tran.	Plot	Empty	Pred. egg	FTSP adult	FTSP pair	LSPE adult	LSPE pair
26 May	2	2	3		1	1			
26 May	2	2	5	1					
28 May	15	1	1	1			1	1	
29 May	4	1	2						1
29 May	4	1	3	2					
29 May	4	1	4	1					
29 May	4	1	6	1					
29 May	4	1	7	2					
29 May	20	1	4	1					
Totals				9	1	1	1	1	1

Pelagic Cormorant: As of our last visit in 1986, Pelagic Cormorants were nesting at only one location on the cliffs on the southwest side of the main island. Seven pairs appeared to be nesting at this time. In 1982, there were 18 nests on islet #1. This site was not used in 1985 or 1986, nor was it occupied at the time of the BCPM survey in 1977. They reported a nesting population of 11 pairs at the site on the southwest cliffs. The population appears to oscillate.

Black Oystercatcher: We did the most thorough search for Black Oystercatcher nests on 16, 17 June 1986 (Table WM280-18). Nests were made of rock chips, mussel, barnacle, and limpet shells.

Table WM280-18. Black Oystercatcher nests around Anthony Island in 1986.

Islet	Empty	1E	2E	3E	3Y	TOTAL	Adults
#1			1			1	1
Rk SW of #2	2					2	2
#16	1			1		2	2
NW pt. of Anthony	1					1	1
#22		1			2	3	4
#24							3
#25		1				1	2
#27				1		1	2
TOTAL	4	2	1	2	2	11	17

Glaucous-winged Gull: We conducted a nest count on 16, 17 June 1986 (Table WM280-19).

Table WM280-19. Glaucous-winged Gull nests around Anthony Island in 1986.

Islet	Start	Emp	1E	2E	3E	4E	1E2Y	1E1Y	TOTAL
#1	4	16	3	21	171	4	4	1	244*
#3		1			10				11
MAIN NW	2				4				6
#22	4	1	1	6	32				44
#24	1	1	1	1	14				18
#25			3	3	19				25
#26					1				1
#27			1	1	1				3
TOTAL	11	19	9	32	252	4	4	1	352*

*There were two inaccessible pinnacles on islet #1 that we could not climb to count nests. The total includes an estimated 20 pairs nesting on these pinnacles. This is an increase from the 237 pairs counted in 1977 by the BCPM.

Nests were made of grass, Cochlearia, and Achillea, with seaweed occurring in nests close to the tide line.

Pigeon Guillemot: Pigeon Guillemots were nesting in rocky crevices and in burrows at the edge of the vegetation around the perimeters of many of the islets. In 1986 (16,17 June), we found 1 nest with 1 egg on the northwest corner of the main island, and 3 nests with 2 eggs on islet #22. The following adults were tallied:

Islet	Adults
#1	14
#3	5
#22	8
#24	10
#25	3
TOTAL	40

The nesting population is much larger than this. We made the best count of Pigeon Guillemots around the islands in 1985, when we tallied a total of 395 birds. We suspect there are 200-300 pairs nesting.

Ancient Murrelet: A small, scattered population of approximately 200 pairs of Ancient Murrelets was nesting on the northeast end of the main island. In 1977, BCPM crews estimated the same numbers.

Ninety Ancient Murrelets were observed off the northeast coast of Anthony at 1900 h on 21 May 1985.

Cassin's Auklet: Cassin's Auklets were burrowing on the main island and on many of the smaller islets, in open forested areas of grass, moss and bare litter, and under the margins of salal and thick young spruce. A large proportion of the population was nesting on the northern islets (Table WM280-20). The mean length of a sample of 38 burrows was 98 $\pm$ 4 cm.

1985 Occupancy Rate: To calculate an occupancy rate, we included burrows from the main island and all surrounding islets whose contents were known. Of 43 burrows along transects whose contents we determined, 32 were occupied this season giving an occupancy rate of 74 $\pm$ 7%. Most of those burrows contained small young (81%). In 4 burrows adults were still incubating. Two burrows contained cold eggs (Table WM280-21).

1985 Nesting Population: 24,737 $\pm$ 3840 pairs.

Rhinoceros Auklet: Rhinoceros Auklets were nesting on many of the smaller islets, but the majority of the population was nesting on the northeast and southwest sides of the main island (Table WM280-22). Most burrows were located in forested areas of grass, moss or bare litter. They occurred under the margins of salal and thick, young spruce, though they penetrated this vegetation less than Cassin's Auklets did. The mean length of a sample of 33 burrows was 153 $\pm$ 15 cm.

Table WM280-20. Summary of Cassin's Auklet colony area and burrow numbers on Anthony Island and the surrounding islets in 1985.

Islet	Average density (burrows/ha)	Number of sample plots	Colony area (ha)	Total burrows
Main island				
- NE side	730 ± 370	3	0.3	242 ± 122
- SW side	1550 ± 330	55	4.8	7439 ± 1584
- pockets			0.13	278
2	3510 ± 830	19	4.0	14,040 ± 3320
3			t	65
4	1320 ± 539	5	1.1	1,386 ± 566
5			0.1	580
6			0.07	545
7			0.05	270
8			t	24
9			t	9
10			t	1
11			t	1
12			0.05	54
15	4100 ± 1400	3	0.1	820 ± 280
17			0.4	278
18			0.1	105
20	1280 ± 520	6	0.5	640 ± 260
21	4730 ± 1951	4	0.5	2,365 ± 975
23	2430 ± 830	16	1.75	4,253 ± 1453
24			t	33
Overall	2388 ± 295	111	14.0	33,428 ± 4132

t: trace

Table WM280-21. Occupancy of Cassin's Auklet burrows in 3x3 m plots along transects on Anthony Island and surrounding islets in 1985.

Date	Location Tran.	plot	Contents: Empty	Cold egg	Adult + egg	Hatched eggshell	Adult + chick	Chick	Total Occupied	Total Known
Main Island										
27 May	3	1	1						0	1
31 May	16	2						2	2	2
31 May	17	2		1	1			1	3	3
31 May	17	3						1	1	1
31 May	17	6						1	1	1
31 May	17	7					1		1	1
30 May	20	1						1	1	1
30 May	20	2	1						0	1
30 May	20	3	1				1		1	2
25 May	25	2						2	2	2
25 May	25	3						1	1	1
25 May	25	4						2	2	2
Islet #2										
26 May	1	2				1			1	1
26 May	1	3	1						0	1
26 May	2	1				1			1	1
26 May	2	5					1		1	1
28 May	3	1			1			3	4	4
28 May	3	2			1				1	1
Islet #4										
29 May	1	2						1	1	1
Islet #15										
28 May	1	1	1		1				1	2
28 May	1	3	1						0	1
Islet #21										
29 May	1	1	1				1	2	3	4
29 May	1	3	2						0	2
Islet #23										
27 May	1	3						1	1	1
27 May	1	4		1					1	1
27 May	2	1	1					2	2	3
27 May	2	7	1						0	1
Totals			11	2	4	2	4	20	32	43

Table WM280-22. Summary of Rhinoceros Auklet colony area and burrow numbers on Anthony Island and the surrounding islets in 1985.

Islet	Average density (burrows/ha)	Number of sample plots	Colony area (ha)	Total burrows
Main island				
- NE side	2140 ± 410	43	4.4	9,354 ± 1792
- SW side	2520 ± 430	44	4.3	10,933 ± 1866
- pockets			0.5	307
2			0.8	289
3			t	3
6			t	10
7			t	8
8			t	3
10			t	2
12			t	1
13			t	1
17			t	18
18			0.1	87
20			t	20
23	275 ± 213	16	1.8	481 ± 373
Overall	1808 ± 220	103	11.9	21,517 ± 2614

t: trace

1985 Occupancy Rate: We determined an occupancy rate on the main island and used it to calculate the nesting population for the entire group (Table WM280-23). Of 33 burrows along transects and in the occupancy plot whose contents we determined, 21 were occupied this season giving an occupancy rate of 64 ± 7%. Birds in these burrows were incubating (Table WM280-23).

1985 Nesting Population: 13,771 ± 2244 pairs.

This population figure is considerably higher than the 2700 pairs estimated nesting by the BCPM in 1977. BCPM crews did not report Rhinoceros Auklets nesting on the southwest side of Anthony Island, where we found the largest concentration. However, we suspect that some Rhinoceros Auklet burrows in this area may have been identified as Cassin's Auklet burrows by crews in 1977. They did report larger burrows here, but as they were unable to determine burrow contents, they attributed them to Cassin's Auklets which are abundant in the same area (BCNRS). The southwest side of Anthony Island is arduous and time-consuming to survey. The more intensive survey methods of

1985 may account for much of the difference in the 1977 and 1985 estimates.

Flocks of Rhinoceros Auklets were observed between Anthony Island and Gordon Islands in 1985 and 1986. We suspect they were feeding and staging in this area as they were present at various times on different days. The maximum sighted was on 21 May 1985 at 1300 h, when there was a single flock of 1900 birds, which was then joined by 1000 birds flying in from the south.

Table WM280-23. Occupancy of Rhinoceros Auklet burrows in 3x3 m plots along transects and in the occupancy plot on Anthony Island in 1985.

Date	Location		Contents			Total occupied	Total Known
	Tran.	Plot	Empty	Adult	Adult + egg		
25 May	23	1			2	2	2
25 May	24	1			2	2	2
27 May	3	1	1			0	1
30 May	20	1			1	1	1
30 May	22	3	1			0	1
31 May	15	1	2			0	2
31 May	16	1	1		1	1	2
31 May	17	1			3	3	3
31 May	17	2		1		1	1
1 June	Occupancy plot		7	1	10	11	18
Totals			12	2	19	21	33

Tufted Puffin: Tufted Puffins were present and presumed nesting on the grassy bluffs on the cliffs on the southwest side of the main island (24 birds), the northwest rocky point of the main island (3 birds), and on the northwest rocky pinnacles of islet #1 (5 birds) (Sightings on 17 June 1986). We estimated 20 pairs nesting.

This indicates a reduction in numbers since 1977 when the BCPM estimated 60 pairs nesting. This is especially evident on the north end of islet #1 where puffins used to nest in burrows in the grass. The BCPM reported 25 burrows here in 1977. In 1982, there were still three burrows here, but by 1985, no puffins remained in this habitat. This area has been visited by surveyors and tourists, and puffins may have suffered from human disturbance. Some birds are still nesting in the more inaccessible rock crevices in this area.

Horned Puffin: Two Horned Puffins were observed and suspected nesting around Islet #1 in 1982. No birds were seen by us in 1985 or 1986, but Keith Moore (pers. comm.) reported approximately 20 Horned Puffins around the northwest rocks at 1500 h on 4 June 1986.

Predation: We kept records of depredated remains found between plots along transects and during our explorations on the main island and all the islets (Table WM280-24). Thirty-seven Bald Eagle pellets were found that contained feathers, two of which also contained Rhinoceros Auklet bills and feet, and Sooty Shearwater feet. Twelve Common Raven pellets contained feathers, three of which also held Cassin's Auklet bills and feet, and one which contained a Tufted Puffin foot.

Disturbance and Recommendations for Protection

Anthony Island receives a growing number of visitors every year. People arrive by helicopter, zodiac, kayak, fishboat, or larger tour vessel. The peak tourist season coincides with much of the seabird breeding season which extends from March to October. The following recommendations are written as a guide for island wardens, tour operators, and the general visitor.

The seabirds that are most sensitive to disturbance are the surface nesting Pelagic Cormorants, Black Oystercatchers, and Glaucous-winged Gulls, and burrowing or crevice-nesting Tufted and Horned puffins. Of the surface nesters, Pelagic Cormorants are most vulnerable, especially during the incubation and early chick stage, which lasts from the beginning of June to the middle or end of July. People around their nesting cliffs, whether on land above or water below, will scare adults off their nests and can quickly cause massive, if not total loss of eggs or small young to opportunistic crows or gulls. Tufted Puffins are easily scared out of their burrows by the presence of people on their nesting slopes, or by the close passage of helicopters, and they will desert eggs from repeated disturbance. They again are most vulnerable during incubation which extends from the beginning of June to early August. Such disturbance may have been the cause of the abandonment of the grassy slope on the northwest islet #1 (see species summary above). Horned Puffins and Common Murres, which we sighted in this area in 1982, would be as vulnerable, and disturbance could effectively prevent them from establishing nest sites.

Effects of disturbance are less obvious for storm-petrels, Cassin's Auklets, and Rhinoceros Auklets, which are nocturnal on their nesting slopes. People walking in colony areas can destroy habitat by inadvertently caving in burrows or trampling vegetation.

We recommend that people be asked to not approach Pelagic Cormorant or Tufted Puffin nesting sites during the breeding season. Puffins and cormorants can be viewed on the water and flying in the vicinity of their nesting areas without approaching too closely and scaring them off nests or out of burrows. Groups of people should be discouraged from walking through any burrowed area, especially without a knowledgeable guide.

Table WM280-24. Depredated remains found during explorations on Anthony Island (main island) in 1985.

Species	Feather piles	Single wing	Pair of wings	Skulls	Depred. egg	Foot
Main Island						
Red-necked Grebe	2			1		
Northern Fulmar				2		
Sooty Shearwater	3					
Fork-tailed Storm-Petrel	7	3				
Black Oystercatcher				1		
Glaucous-winged Gull				1		
Black-legged Kittiwake	2					
Ancient Murrelet	5	1			4	
Cassin's Auklet	10	1	1	4		
Rhinoceros Auklet	27		3	14		
Tufted Puffin						1
Belted Kingfisher	1					
Islet #2						
Fork-tailed Storm-Petrel	3	1				
Mallard	1					
Black-legged Kittiwake	2					
Islet #4						
Cassin's Auklet	1					
Islet #6						
Fork-tailed Storm-Petrel	6	1				
Cassin's Auklet	1					
Islet #7						
Fork-tailed Storm-Petrel		1				
Leach's Storm-Petrel		1				
Cassin's Auklet		1				
Islet *#10						
Cassin's Auklet			1			
Islet #13						
Cassin's Auklet	1					
Islet #17						
Cassin's Auklet	1					
Islet #20						
Cassin's Auklet	1					
Islet #21						
Cassin's Auklet	6					
Islet #23						
Cassin's Auklet	1					
Rhinoceros Auklet	1					

Associated species: 1985 observations, unless otherwise noted.

Bald Eagle - Seen constantly. Maximum number of eagles seen at one time were 3 adults and 5 immature. On 21 May at 2245 h one seen in forest north of Ninstints. We found 11 nests in the Anthony Island group (Fig. WM280-1):

1. On main island on southwest side at the south end. Nest is 35 m up in 45 m Sitka Spruce on a forested knoll with grass understory about 10-15 m from the edge. Pair of adults in area 20 May.

2. Nest of sticks with saxifrage growing out of it 25 m up in 40 m spruce, 10-15 m from edge. Nest is close to nest #1.

3. On west side of island on point between 2 main west bays. Nest of sticks 20 m high in 30 m spruce 8 m from edge of bay to south and about 55 m from seaward end of ridge. Additional observations were made: 22 May - Adult in nest. 25 May - Adult in nest with at least 1 chick. At 1440 h second adult arrived with food. Both adults departed nest at 1445 h. At 1600 h an adult returned with dark grey bird in talons. Peregrine Falcon calling and diving on Bald Eagle briefly. 30 May - At 1330 h adult flew in from sea with a bird in talons, possibly a Sooty Shearwater, then partially plucked the bird in a nearby tree.

4. Nest on northern islet #2. Nest of sticks 25 m up in a 90 cm dbh spruce 5 m from shore on northwest end of islet. On 26 May no sign of activity.

5. Nest on northern islet #2. Nest of sticks on mid-western side of islet 25 m up in 35 m high spruce 10 m from shore. On 26 May heard eagles calling nearby.

6. Nest on northern islet #2. On south end of islet nest of sticks 20 m up in 30 m Sitka Spruce 10 m from shore in crotch of tree.

7. Nest on northern islet #2. Nest of sticks 15 m up in forked snag 40 m high, about 10 m from shore at southeast end of islet.

8. Nest on northern islet #5. Nest of sticks 25 m up in 40 m high Sitka spruce, 30 m from shore in leaning spruce in center of island.

9. Nest on northern islet #15. Nest of sticks with grass growing out of it. Nest 25 m up in 40 m high spruce, 15 m from shore. 28 May - no adults observed.

10. Nest on east end of islet #23. Nest is a 3 m high stack of sticks, 30 m up in 40 m spruce 10 m from shore. On 27 May one adult seen flying into tree.

11. Nest near the middle portion of islet #23. Nest of sticks with grass growing out of it 25 m up in 30 m three-pronged spruce approximately 20 m from the north shore on edge of shute cutting through the island.

Peregrine Falcon - One pair heard and seen regularly along southwest side of the island around the crevice cliffs. One frequently chasing Bald Eagles over Ninstints village. Two males seen 2 June on southwest side, 1 with a Cassin's Auklet in talons. Two chasing each other 30 May.

Marbled Murrelet - 1 June, in breeding plumage.

Northwestern Crow - Regular. We found one nest on west side of island in northwestern-most of two main bays on west side. Nest was under driftlogs at upper level of beach just 1 m before vegetation edge. Nest of twigs lined with grass and redcedar bark strands. Nest contained 4 eggs on 25 and 30 May.

Common Raven - Regular. One nest on interior side of ridge south of the west bay about 70 m east of ridge top. Nest of sticks on first large branch above ground against trunk, 20 m up in 45 m hemlock, dbh 0.8m. 20 May - Three fully feathered young standing in nest and calling. One perched on adjacent branch then hopped back into nest. 31 May - Three immature ravens perched around in various trees north of nest tree calling in high voices. Two adults flew in, 1 carrying prey. Adult calls were deeper than young. 2 June - Three fledged young and 2 adults in vicinity near and on ground.

Two worn muddy patches of ground, one about 25 m and the other 50 m from the nest tree, were littered with prey remains and raven pellets. Remains of gooseneck barnacles, sea urchins, chitons, abalone, fish, crabs, Cassin's Auklets, Rhinoceros Auklets, and a Black Oystercatcher were all found. Most pellets identified as Common Raven contained chiton plates and feathers.

Sitka Deer - All over islets. On some of the northern islets, deer have browsed patches of salal down to ground level. Maximum of 4 seen around Ninstints.

River Otter - Three seen feeding in northern bay on 23 May. Runways were seen in many areas on the main island and on most of the islets. Dens and areas of heavy use were noted on the main island under roots of a tree near Transect 13, on the peninsula on the south side of the village site and north of the village site. Islets 8,9,10,14,17,19,20 and 23 all were recorded as having heavy use by river otters.

Harbour Seals - Maximum of 12 seen hauled out on adjacent reefs of south islets on 27 May. On 4 June, at south islet #21 adult seal with newborn pup still with umbilical cord attached.

Northern Sealion - On haul out rock off west side of Anthony Island (islet #25). In 1985, maximum of 35 seen on 27 May. On 28 May six seen in south bay of Ninstints village. In 1986, there were 50 present.

Other sightings:

All sightings are in 1985 unless otherwise noted.

Common Loon - 19 May-1 June. One or 2 breeding birds in south bay of Ninstints.
Great Blue Heron - 22 May. One at north end of island.
Spotted Sandpiper - 23 May.

Whimbrel - Two on 26 May at north end.
Rufous Hummingbird - Seen regularly. Male seen in display flight, feeding on twinberry. Maximum of 4 seen (suspect fledged young) near Ninstints on 1 June.
Belted Kingfisher - Seen in 1982.
Hairy Woodpecker - regular.
Western Flycatcher - regular.
Eastern Kingbird - 1982 at Ninstints.
Black-billed Magpie - Seen 29 May on islets #22 and #23.
Chestnut-backed Chickadee - regular.
Winter Wren - regular. Nest on west side:
22 May - three fledged young perched under roots of small spruce tree. two adults present.
31 May - Three fledged young on west side.
2 June - Three fledged young and two adults.
Swainson's Thrush - First heard 21 May, then regularly thereafter at dawn and dusk.
Hermit Thrush - regular.
Varied Thrush - regular.
Oranged-crowned Warbler - regular.
Townsend's Warbler - regular.
Wilson's Warbler - heard 22 May.
Fox Sparrow - regular. Three nests were found:
1. 23 May. In bays at north end of island. Nest in 1.5 m high spruce regen. 1 m above ground, formed of moss lined with grass, 5 m from beach and 1 m into spruce seedlings. Contents: 2 downy chicks with eyes open. 2 adults feeding.
2. 29 May. On northern islet #4. Nest in Calamagrostis sp. tussock on log. Nest made of grasses. Contents: 3 young, large chicks, well formed feathers under down, pinfeathers extensive on wings. Two adults in tree nearby. One with food.
3. 30 May. Ninstints village. Two chicks with 2 adults.

Song Sparrow - regular. Three nests were found:
1. 20 May. South end of main island. Nest of woven grass lined with deer hair, in tussock of Calamagrostis sp. Contents were 3 eggs, adult scared off.
2. 29 May. On northern islet #4. Nest of woven grasses lined with deer hair, in Calamagrostis sp. tussock. Contents were 3 eggs, adult scared off.
3. 29 May. On south island #22. Nest of grasses lined with fine grasses, in Calamagrostis sp. tussock. Contents were 3 eggs, adult flew off and chipped from nearby spruce seedling.
Red Crossbill - regular. Maximum of 28 on 21 May.
Pine Siskin - regular. Maximum of 11 on 20 May.

Location: On the west side of Kunghit Island at the entrance to Houston Stewart Channel. 52°06'28"N 131°10'W.

Land status: Part of South Moresby National Park Reserve.

Date of visit: 5 June 1985 (1300 h) and 16 June 1986 (1350-1545 h).

Colony access: Drop-off from boat.

Observers: 1985: M. Lemon, M. Rodway, D. Garnier, D. Power. 1986: M. Rodway, D. Garnier, D. Grinnell.

Census method: In 1985, we only boated around the island. We did a total count on the island in 1986.

Description: This 3.4 ha rock is 21 m high with deeply creviced, cliffy sides and a stepped, flat top. There are thin, horizontal crevices under large slabs of rock on the top. Grass and scattered forbs such as Fritillaria and Rumex grow along cracks in the rock. On the higher northeast side is a wet area with sedges and Conioselium (hemlock parsley).

Nesting species:

Black Oystercatcher: We found 2 nests in 1986; one with 2 eggs and one with 3 eggs. Nests were made of rock chips and limpet, mussel, abalone, and blue top snail shells.

Glaucous-winged Gull: In 1985 we counted 196 adults standing on territory. In 1986, the following nests were recorded:

Start	Emp	1E	2E	3E	4E	2E1Y	1E2Y	1E1Y	3Y	2Y	1Y	TOTAL
5	3	5	10	114	4			1	2	1		145

Nests were made of grass, Fucus, Cochlearia, Achillea, Saxifraga, fresh salal leaves, spruce twigs, Heracleum, Angelica, and Rumex. The eggs in six of the 3 egg nests were pipping. All nests with young and/or pipping eggs were located on the highest portion of the island.

Pigeon Guillemot: In 1985 there were 2 on the water around the island. In 1986, we found the following:

1E	2E	Adult on eggs	Adults
2	2	1	24

Tufted Puffin: In 1985, we saw 3 fly out of crevices. In 1986, 8 incubating adults were found in rock crevices. Three other adults were seen flying out of crevices. Eight adults were counted on the water around the island, giving a minimum total of 16 adults present.

Associated species:

Pelagic Cormorant - 1985: 2 in breeding plumage and 5 immatures were on the rocks on the west side. 1986: 66 roosting (2 with breeding patches). No nests were seen.

WM-300 GORDON ISLANDS 103 B/3

Location: Off the west side of Kunghit Island. 52°06'N 131°08'30"W

Land status: Part of South Moresby National Park Reserve.

Date of visit: 21 May 1985, 1000-1800 h (main survey) and 16 June 1986, 1550-1555 h (small rocks off the northwest corner).

Colony access: Landing beach at north end of largest island.

Observers: 1985: M. Lemon, M. Rodway, D. Garnier, D. Power. 1986: M. Rodway, D.Garnier, D. Grinnell.

Census method: Exploration and partial count.

Description: These islands are composed of a series of dissected rocky knolls with steep, often cliffy sides. Their total area is 38.4 ha. The knolls are higher with larger cliffs towards the south end. Most of the area is covered with dense salal (0.5-2.0 m high) under a sparse spruce forest with a number of old silvered snags. Twinberry, salmonberry and crabapple are scattered in lower areas. Small mossy and grassy patches with Maianthemum and other flowering herbs occur along the rim of the vegetation. Some of the salal around the edges has been heavily browsed by deer.

Nesting species:

Glaucous-winged Gull: There were two adults off the west side in 1985. In 1986, we found 1 nest start on the northwest rocks. A few Cochlearia stems had been collected by 2 adults.

Pigeon Guillemot: In 1985, we counted 25 adults on the water: 22 around the cliffs on the southeast side, and 3 along the west side. In 1986, there were 26 along the west side of the main island.

Cassin's Auklet: Cassin's Auklet burrows were found in open grassy and mossy fringes around the rims of the raised knolls under live roots, stumps and the edges of the thick salal. Burrows extended to a maximum of 15 m from the edge of the vegetation, but most occurred within 5 m of the edge. Most burrows were located around the higher knolls towards the south end, but we found a few near the north end as well (Fig. WM300-1). We counted a total of 634 burrows and estimated 250 more in areas that were difficult to access, giving an overall estimate of 900 burrows for the islands. Most burrows appeared active with fecal streaking, regurgitated food and sometimes hatched eggshells at the entrances. No occupancy rate was determined. We

estimated 700 pairs nesting.

Rhinoceros Auklet: Rhinoceros Auklet burrows occurred in the same areas as Cassin's Auklet's. A total of 67 were counted and we estimated another 30 to give a total of 100 burrows for the islands. Burrows were distinguished by size and droppings at the entrance. About 10 of these burrows were large enough to be Tufted Puffin burrows. There were no droppings at their entrances, but some had signs of recent digging. We estimated 80 pairs of Rhinoceros Auklets nesting.

Tufted Puffin: See Rhinoceros Auklet account above. We saw no Tufted Puffins near the island in 1985. There was one Tufted Puffin around the island in 1986.

Predation: We found 1 Cassin's Auklet wing, 1 Red-necked Grebe feather pile, and 1 Black-legged Kittiwake feather pile.

Associated species: (Sightings are from the survey in 1985)

Pelagic Cormorant - 20 between Gordon Is. and Bowles Pt. on 21 May.
Bald Eagle - 1 nest of sticks 25 m up in 40 m spruce 5 m from shore at the southwest corner. 1 adult on the nest. 3 immatures were also seen.
Peregrine Falcon - 1 pair.
Northwestern Crow - 6
Common Raven

Sitka deer - trails throughout islets.
River Otter - Runs and scats were observed.
Northern Sea Lion - 1 off west side of island on 21 May.
Hair Seal - 2
Whale - tentatively identified as a Sei Whale, seen west of Gordon Is. on 21 May.

Other sightings: (1985)

Pacific Loon - 3 west of Gordon Is. on 21 May.
Common Loon - 1 south of Gordon Is. on 21 May.
Wandering Tattler
Rufous Hummingbird
Winter Wren
Hermit Thrush
Orange-crowned Warbler
Fox Sparrow
Song Sparrow
Pine Siskin

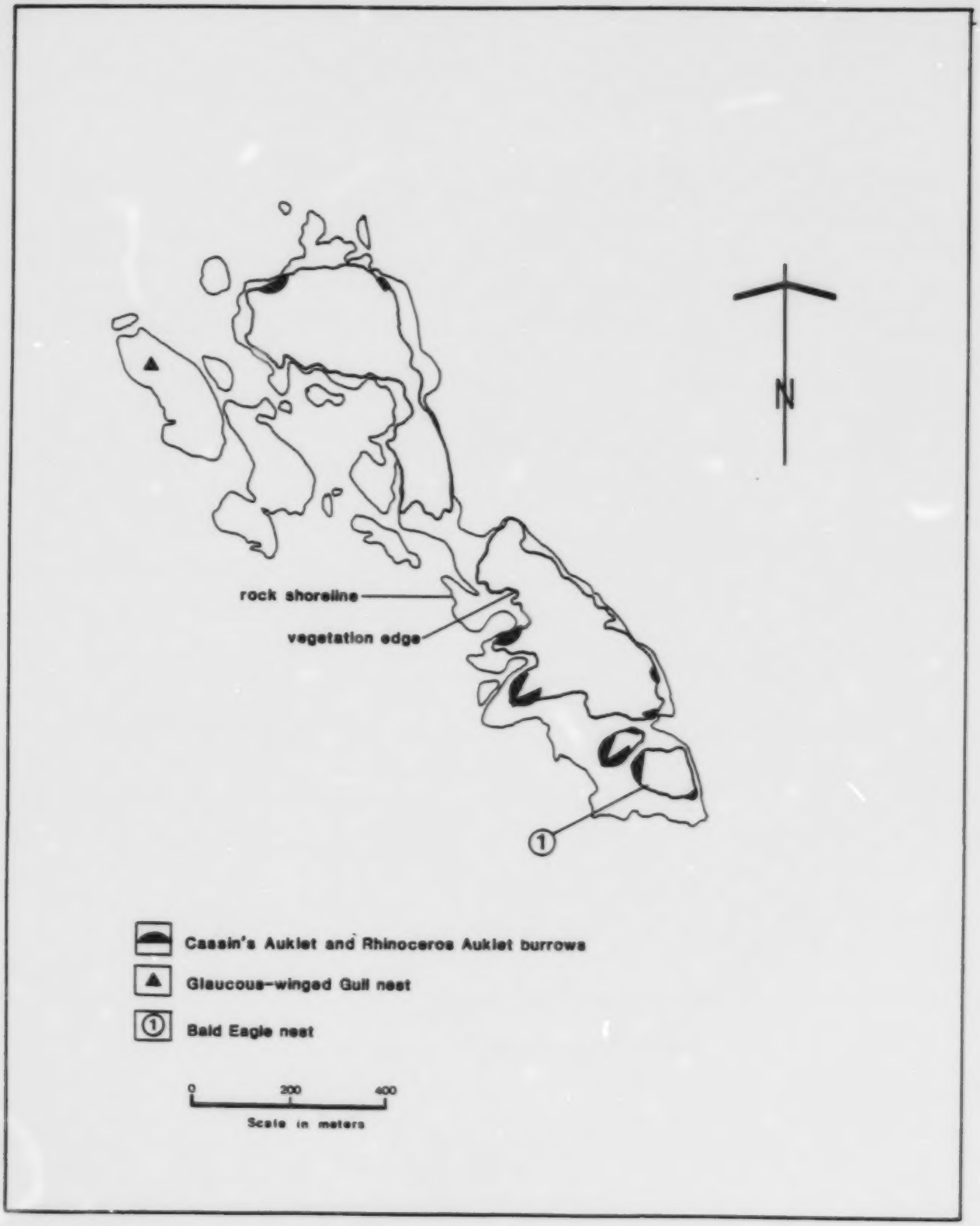

Figure WM300-1. Seabird colony areas on Gordon Islands in 1985.

WM-310 ST. JAMES ISLAND 103 O/14

Location: At the south tip of Moresby Island 51°56'10"N 131°01'W

Land status: Part of South Moresby National Park Reserve.

Date of visit: 10 June 1986, 1200-1700 h and 12 June 1986, 1100 h.

Observers: M. Lemon, M. Rodway, G. Kaiser, D. Powell, D. Garnier, D. Grinnell, H. Hay, N. Holmes.

Census method: Exploration and count from boat.

Description: St. James is a rugged 19 ha island with cliffs and crevices on the south and west sides, and steep slopes and bluffs on the east and north sides. It rises to a maximum elevation of 96 m. There is a draw across the middle which divides the island into higher north and south sections. Most of the steep perimeter is bare rock with grass growing on higher ledges. The top of the southern section and into the draw is grassy with no trees. There are scattered spruce seedlings and salal on some of the shelves above the cliffs. The northern section is forested with spruce. The trees are smaller, with a bare litter understory on the south slopes, and lush forbs, especially Maianthemum, carpet the slopes under larger spruce with a more open canopy on the east and north sides. On the perimeter of the forest are grassy slopes with dense patches of salmonberry, and a fringe of small regenerating spruce and a few hemlock on the west side. There is a manned weather station on the south section.

Nesting species:

Pelagic Cormorant: 6 nests were counted on the cliffs on the southwest corner. Adults were incubating.

Glaucous-winged Gull: 152 gulls were counted on territories on rock and grassy ledges and slopes along the west side from the southwest corner to the draw between the south and north sections of the island (Fig. WM310-1). 33 could be seen to be obviously incubating. 36 nests were accessible on the southwest corner with the following contents:

Empty	1E	2E	3E
7	3	4	22

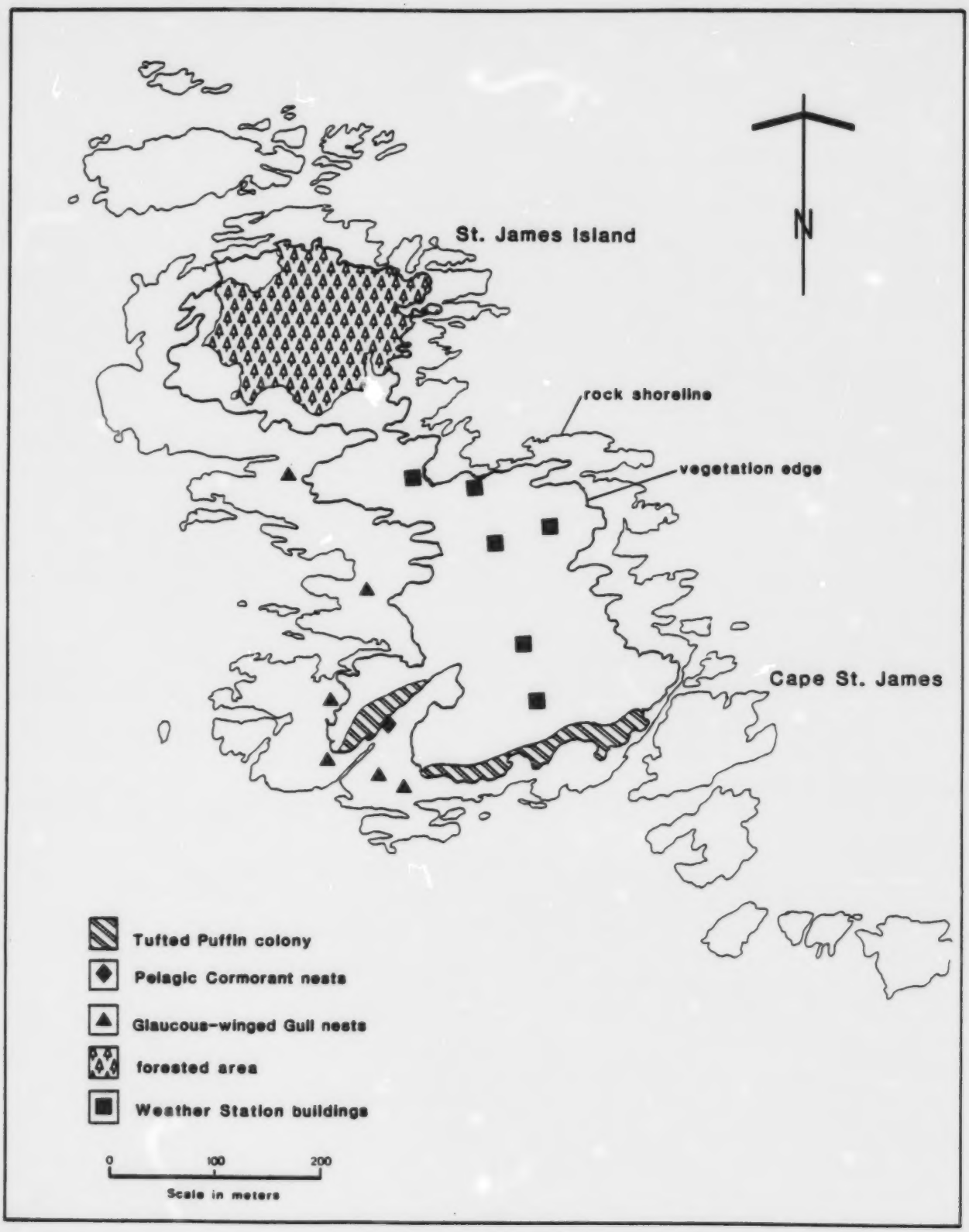

Figure WM310-1. Seabird colony areas on St. James Island in 1986.

Pigeon Guillemot: 16 adults were counted on the water around the island.

Cassin's Auklet: We found no evidence of nesting by Cassin's Auklets.

Horned Puffin: 1 adult circling with Tufted Puffins.

Tufted Puffins: Puffins were nesting on the steep, inaccessible slopes on the south and southwest sides (Fig. WM310-1). A maximum of 30 birds were observed circling this area (1400 h). We suspect the total population to be at most 100 pairs. This was a maximum figure estimated by employees at the weather station who had been observing the puffins through the season.

Associated species:

Black Oystercatcher - 3
Northwestern Crow - 4 nests against trunks of small spruce.

River Otter - runs and scats of fish at the north end.

Other sightings:

Rufous Hummingbird
Orange-crowned Warbler
Song Sparrow
Fox Sparrow

WM-320 KEROUARD ISLANDS 103 O/14,15

Location: At the south end of the Queen Charlotte Islands. 51°55'N 131°00'W

Land status: Provincial Ecological Reserve. Part of South Moresby National Park Reserve.

Date of survey: 10 June 1986, 1100-1330 h and 2150-2250 h, and 12 June 1986, 1030-1800 h.

Colony access: Drop-off from boat.

Observers: M. Rodway, D. Grinnell, M. Lemon, G. Kaiser.

Census method: All the islets were circumnavigated by boat, though we did not approach too closely to Sea-Lion Rock to prevent disturbance of the sea-lions. The vegetated areas of mile 1 and the largest northern portion of mile 2 islet were explored on foot by M. Rodway. One transect was run across mile 1 island though the accessible habitat at a bearing of 60° from west to east. Burrows were counted in 1x1 m plots every 5 m. No other transects were run. Extent of burrowing was drawn on 1:5000 air photos based on the explorations made, and the area was calculated using a compensating polar planimeter.

Description: The larger islets of this group of rugged, precipitous rocks have steep grassy slopes towards the east, and rounded, grassy tops. The grass is primarily Calamagrostis, with Elymus on the edges and other species mixed throughout. Montia, Saxifraga, and some moss also mix with the grass. On the lower east slope of mile 1 island where few burrows were found, the grass tussocks reached heights of 1.5 m, with meter thick bridges of dead stalks between them. Where burrows were abundant, runways among these tussocks were worn clear. The total area of these islands is 24.5 ha (mile 1 - 14.0 ha; mile 2 - 10.5 ha), with a vegetated area of 7.4 ha (mile 1 - 4.4 ha; mile 2 - 3.0 ha).

Nesting species:

Glaucous-winged Gull: No nests were inspected; the following numbers of adults on territories were counted from the water:

1 mile:	E side	21
	S end	19
	W side	8
	Total	48
Sea-Lion Rock:	E side	12
	W side	26
	Total	38
2 mile:	N rocks	9
	SE rock	28
	W side	28
	Total	65
	TOTAL:	151

We estimated 75 nesting pairs.

Pigeon Guillemot: The following numbers were counted on the water and on the rocks:

1 mile:	E side	21
2 mile:	E side	47
	TOTAL	68

Common Murre: 300 were flying around the south end of mile 2 at 2230 h on 10 June. Few murres were seen in the area during the day. No nesting was observed in 1986, but A. Whitney (pers. comm.) counted 400 on nesting ledges on 4 July 1987.

Cassin's Auklet: Cassin's Auklet burrows were dense over almost all of the grassy habitat that was explored (Fig. WM320-1, Table WM320-1). The only area where burrows were not found was on the lower 30 m of the slope on the east side of mile 1 island. Burrowing appeared heavier in the area explored on mile 2 island than on mile 1. Much of the ground, especially on mile 2 island, was riddled with burrows and very unstable to walk on.

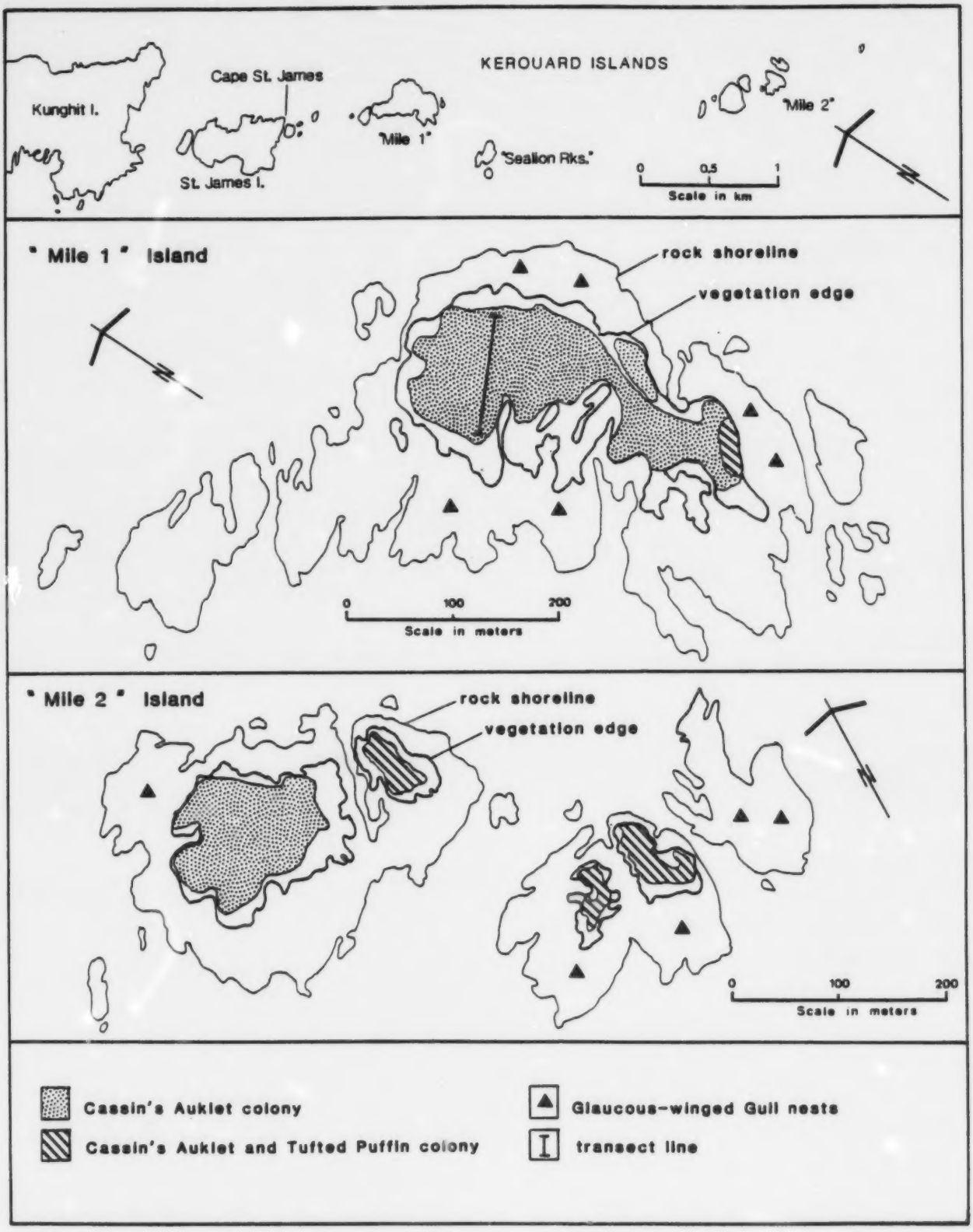

Figure WM320-1. Seabird colony areas and transect location on Kerouard Islands in 1986.

Table WM320-1. Number of Cassin's Auklet burrows in 1x1 m plots along transect on Kerouard Islands in 1986.

Distance along transect (m)	Number of CAAU burrows	Notes
0	3	50° slope
5	3	
10	4	
15	2	
20	0	
25	1	
30	3	
35	3	
40	4	
45	2	
50	1	crest of island
55	4	
60	3	
65	3	
70	4	
75	3	
80	2	
85	1	
90	1	becoming steep
95	1	45-50°
100	0	
105	2	
110	2	
115		drops to west

Number of sample plots: 23 (23 m^2 - 0.1% of colony)

Average Density: 22600 $\pm$ 2600 burrows/ha

This density figure was used to calculate an estimate of the total number of Cassin's Auklet burrows on the Kerouards. On mile 1 island, higher densities were encountered on the south and west sides (up to 7 burrows/m^2), and, as previously noted, densities were generally higher on mile 2 island. Thus the above figure is considered conservative.

Colony Area:

mile 1:	2.7 ha (2.6 ha explored)
mile 2:	1.9 ha (1.4 ha explored)
Total:	4.6 ha

Total Burrows:

mile 1:	61,235 $\pm$ 7,045
mile 2:	42,678 $\pm$ 4,910
Total	103,913 $\pm$ 11,955

1986 Occupancy rate: No occupancy rate was determined. Few burrows were excavated. One ready-to-fledge chick with an adult was found in one burrow near the crest of mile 1. One freshly dead chick of fledging age was found on the southern slopes of mile 2 island. It had no obvious impairment. A maximum of 3 adults were seen on the water around the Kerouards during our survey.

1986 Nesting population: Using the B.C. median occupancy rate of 75%, we estimated a total nesting population of 77,935 ± 8,966 pairs.

Tufted Puffin: The only Tufted Puffin burrows located were at the south end of mile 1 island on 15-30° slopes above the south cliffs. They occurred within 5-10 m of the edge of the vegetation, sparsely mixed with the much more abundant Cassin's Auklet burrows. Only 6 Tufted Puffin burrows were found and explored. The ends of two were reached: one was empty, and one contained a defensive adult who was disturbed no further. Sixty burrows were estimated in this area. More puffins may have been nesting in the rocky habitat of the cliff-face below. On the west side of mile 1 island there is a small grassy rock below the cliffs, that appeared through binoculars to have some large burrows and runways.

No Tufted Puffin burrows were found in the accessible grassy slopes of the main section of mile 2 island. Five puffins were flying around the cliffs on the south side (1445-1510 h) and may have been nesting. We suspected nesting on the cliffs on the southeast and west sides as well. More puffins were flying around the southeast grassy sections of mile 2, where some were seen entering burrows. This is where we observed the most circling in the evening (see below), and is probably where the bulk of the nesting population occurs.

The following numbers of flying Tufted Puffins were counted from the water on 10 June 1986:

	1100-1200 h	2205-2240 h
mile 1: S side	2	100
W side	80	0
mile 2:SE end	16	800

We estimated the breeding population to be:
mile 1: 100 pairs (50-200)
mile 2: 500 pairs (200-800)
Total: 600 pairs (250-1000)

Associated species:

Ancient Murrelet - 1 offshore
Rhinoceros Auklet - 6 offshore
Peregrine Falcon - 1 pair (1 eyrie)
Bald Eagle - 1 adult, 7 immature
Northwestern Crow - 5
Common Raven - 1

River Otter - trail and scats of fish on the northeast corner of mile 2.
Slugs - abundant- mainly plain dirty green; some with black spots.
Carrion Beetles (Nicrophorus) - abundant- orange markings.
Northern Sea-Lion: mile 1 - 11
Sea-Lion Rock - 727 (6+ harems with pups)
mile 2 - 82 (3 groups)
Total 820

There was no sign of deer on the islands.

Other sightings:

Sooty Shearwater - 1000's streaming south, passing between mile 1 and 2 islands from the northwest
Herring Gull - 1 immature
Rufous Hummingbird - 1 female
Song Sparrow - 10's
Fox Sparrow - 10's

AREAS EXPLORED WITH NO HISTORY OF NESTING BY SEABIRDS

During the course of our surveys, we explored a few areas that had no evidence of nesting by seabirds. We include them here as a record of our observations.

"HASTINGS" ISLET

Location: Inskip Channel, east of Englefield Bay. The islet sits in the bay directly north of Hastings Pt. 53°0'50"N 132°15'54"W

Date of survey: 18 May 1986 (1530-1600 h)

Observer: D. Grinnell, M. Rodway

Census method: Exploration.

Description: This 1.0 ha islet is a rocky dome-shaped island of low relief and undulating topography. It has a mossy ground cover under a forest of Western Redcedar, Western Hemlock and some Sitka Spruce. Many of the larger cedars have dead tops. A few Sitka Alder grow along the shore. There was no sign of nesting by seabirds.

Sightings:

Pigeon Guillemot - 2 birds seen in the bay north of Hastings Point.
Marbled Murrelet - 1 single, 1 pair and a group of 3 birds between this islet and Instructor Island.
Bald Eagle - 1 adult and 1 immature on Hastings Point.
Hair Seal - 1
River Otter - lots of runways and scats. Many abalone and clam shells scattered through the forest.

MORESBY ISLAND HEADLANDS

Location: In Englefield Bay northeast of Helgesen Island.
53°1'52"N 132°25'20"W and 53°2'15"N 132°26'6"W

Date of survey: 18 May 1986 (1710-1800 h)

Observers: M. Rodway, D. Grinnell

Census method: Exploration.

Description: The headlands southeast and west of Boomchain Bay were explored. The southeast headland is rocky with grassy slopes under spruce on both the north and south sides, and rises to about 20 m elevation. The point separating Boomchain Bay from the bay to the west, is a steep-sided rocky headland rising abruptly to about 50 m elevation. An open moss ground cover under a mature hemlock, cedar and spruce forest extends up the nose of the ridge to the height of land. There are clear, seaward-facing slopes.

Sightings: There was no sign of burrowing or other seabird use on either of these headlands.

TOTAL BREEDING POPULATIONS ON THE WEST COAST OF MORESBY ISLAND

The West Coast Moresby region supports almost half a million breeding seabirds, including 239,000 Cassin's Auklets, 122,000 storm-petrels, 68,600 Rhinoceros Auklets and 39,300 Ancient Murrelets (Table WM-1). Concentrations occur in Englefield Bay and at the south end of the region around the west side of Kunghit Island. Table WM-1 includes data for a few small colonies of Black Oystercatchers, Glaucous-winged Gulls and Pigeon Guillemots not surveyed since 1977. Population estimates from 1977 (Campbell and Garrioch 1979; British Columbia Nest Record Scheme) for those colonies have been included to present total estimates for the region. Historical data interpreted in Rodway et al. (in prep) has been used to list extinct or unused colonies.

The following codes have been used on Table WM-1 to indicate the type of population estimates presented. A more detailed definition of these codes can be found in Rodway et al. (in prep).

S: breeding suspected but not directly observed

x: breeding confirmed but population not estimated

e: population estimated without systematic sampling or total counts

t: population estimated from systematic sampling along transects

26: a number without a code indicates a total count

E: extinct

(): number of birds in breeding plumage on or near the colony

Acronyms for species names follow Campbell and Harcombe (1985) [see Appendix VI]. "SP-T" means total storm-petrels.

Table WM-1. Current summary of breeding seabird populations on the west coast of Moresby Island. Estimates are of breeding pairs for all species except Common Murres, Pigeon Guillemots and Tufted Puffins. To include those species, total populations are given as individual birds. Data codes and sources are explained on previous page.

SITE CODE	SITE NAME	SP-T	FTSP	LSPE	PECO	BLOY	GWGU	COMU	PIGU	ANMU	CAAU	RHAU	TUPU	HOPU	TOTAL BIRDS	SURVEY YEAR(S)*
WM-010	"Buck Channel" I.	250e	S	250e	x				S						500	1977
WM-020	Saunders I.					5	7eS		S(8)	50e	E	E			132	1986
WM-030	Helgesen I.	180t	180t			1S			(0)	7700t	3700t	16600t	(0)		56362	1986
WM-040	Willie Island		E	E		0			S(25)	10eS	170tS	80tS			545	1986
WM-050	Carswell I.	270eS							(0)	1700eS	180eS	20eS			4340	1986
WM-060	"Inskip" Cave				5										10	1977
WM-070	Instructor I.	1600t	x			1			S(17)	760tS		850tS			6439	1986
WM-080	Lihou Island	13700t	x	x	0	1			S(80)	6500t	11200t	2700t	S(27)		68309	1986
WM-090	Bone Point				(1)	1S	18eS		S(29)				S(12)		79	1986
WM-100	Luxmoore I.	5700t	x	x					S(2)	1000tS	380t	300tS			14762	1986
WM-110	Rogers Island	28700t	S	x		1			S(20)	1700tS	40eS	20eS			60942	1986
WM-120	Cape Kuper									10	120	10S			280	1986
WM-130	Moresby Islets						1S		(1)		80e	40eS			243	1986
WM-140	Ariel Rock					1									2	1977
WM-150	Longon Islets					2	34		4x(14)						86	1977
WM-160	Horn Rock						3								6	1977
WM-170	"Mike" Rock						7e								14	1977
WM-180	"Cone" Islet	S						S(40)	S(8)				S(60)		108	1977
WM-190	"Between" Islet						6eS		2+eS(4)		100eS		(1)		217	1977
WM-200	"Goski Bay" Its.					2	1		1x(5)						11	1977
WM-210	Nanguai Islands	2	2			3	1		S(8)						20	1977
WM-220	Goudas Islands					1	21		10e(20)						64	1977
WM-230	"Victoria" Rk.						19eS		S(3)						41	1986
WM-240	"Keyhole" Rk.						11eS						S(26)		48	1986
WM-250	"Mclean Fraser"						5eS		S(2)						12	1986
WM-260	"Louscoone" Rks					3									6	1986
WM-270	Adam Rocks					3	48		S(20)				S(4)		126	1986
WM-280	Anthony Island	10700t	2100t	8600t	7	11	352		S(395)	200e	24700t	13600t	S(32)	S(20)	99587	1985,86
WM-290	Flatrock I.				0	2	145		5x(24)				11(16)		340	1986
WM-300	Gordon Is.						1		S(26)		700e	80eS	(1)		1589	1985,86
WM-310	St. James I.				6	2S	76e		S(16)		0		x(30)	S(1)	215	1986
WM-320	Kerouard Is.				0		75e	S(400)	S(68)		78000t		x(900)		157518	1986,87
	TOTAL NESTING PAIRS	61102	2282+	8850+	18	40	831			19630	119370	34300				
	TOTAL BREEDING BIRDS	122204	4564+	17700+	36	80	1662	440	795	39260	238740	68600	1115	21	472953	
	NUMBER OF SITES	9	8+	5+	4	16	19	2	22	10	12	11	11	2	32	

METHODOLOGICAL CONSIDERATIONS AND RECOMMENDATIONS

The goal of the inventory program was to establish baseline estimates of breeding seabird populations using replicable survey techniques. Total counts conducted at the appropriate time are readily compared. Partial counts are adequate to detect substantial changes in nesting distribution and population on small colonies. Changes in population estimates for large colonies are more difficult to interpret. The level of precision of estimates derived from systematic sampling along transects depends on the precision of three components which enter into their calculation: colony area, burrow density and burrow occupancy rate. Each component has its own sources of error.

In the methods presented in this report, there is no measure of error for colony area calculations, and its level of precision is unknown. Distance, slope and elevation measurements taken along transects help delineate nesting areas, but precise identification of colony boundaries depends on thorough exploration, careful observations and detailed and explicit note-taking. Sources of error arise whenever observations or field notes are not comprehensive enough to allow unequivocal definitions of colony limits. Training of observers in what evidence to look for, and how to record it unambiguously, is an essential element of an inventory program and directly influences the quality of data obtained. Having an experienced corps of surveyors from year to year maintained a consistent standard for defining colony limits. The accuracy of mapping and measuring colony areas also depends on the quality and scale of available maps.

The standard error of the average burrow density has been calculated for each site. The level of precision and accuracy depends on burrow distribution, sampling intensity and appropriate selection of quadrat size and spacing. Compromises were made between the level of precision desired and the time required to obtain that level. Average densities for small colonies often have large standard errors because they were sampled with few plots. Observer bias in indentifying burrows may create an unmeasured subjective error especially for Ancient Murrelet burrows, some of which require careful examination to distinguish from holes in the ground. Consistent criteria, experienced observers and mutual consultation minimized discrepancies. Studies are required to evaluate the importance of this bias.

Burrow occupancy rates were not obtained at most colonies along the west coast of Moresby Island due to lack of time. Also, most surveys were conducted between April and June to coincide with the nesting of Ancient Murrelets and Cassin's Auklets, and were too early to obtain accurate information for storm-petrels. Though we were able to calculate proportions of Fork-tailed Storm-Petrels at some colonies, overall occupancy rates for storm-petrels are lacking at all colonies on the west coast of Moresby Island.

Digging alcid burrows to determine occupancy is a laborious and time-consuming task. Often half or more of the attempts are unsuccessful. At the few colonies where we did determine occupancy rates, it was not feasible to determine the occupancy of burrows within all quadrats, and occupancy was determined in only some of the quadrats. Selection of quadrats was not systematic or random, but typically resulted from the delegation of an amount of work to be accomplished in one day. We recommend not attempting to explore burrows in all quadrats unless more time is spent than on the present surveys. On storm-petrel and Cassin's Auklet colonies in other regions of the coast, we selected quadrats randomly and set a fixed sample size of five burrows at each plot selected (see Rodway et al. 1990 and Rodway and Lemon in prep (b)). This

method facilitates statistical analysis and comparison and we recommend it for future surveys.

There may be an advantage to sampling burrow occupancy separately from burrow density. Effort spent exploring burrows was more productive when determining occupancy was the sole objective of the activity. Excavating burrows within plots along transects was generally less efficient due to the continual switching of activities from recording and measuring to digging. Research on the variation in occupancy rates within and between colonies, and over time, is required to assess and improve sampling methodology (see Gaston and Jones 1984; Gaston and Collins 1988).

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APPENDIX I. Median occupancy rates for burrow-nesting seabirds in British Columbia (percent).

At a number of colonies of burrow-nesting seabirds that were surveyed, no occupancy rate was determined, either because the colony was too small, the survey was done too early in the breeding season, or it was too difficult and time consuming to determine the contents of an adequate sample of burrows. To estimate nesting populations at these colonies, we calculated a median occupancy rate for each species from all colonies in British Columbia where occupancy rates had been determined.

	Species				
Colony	Storm-Petrel	Ancient Murrelet	Cassin's Auklet	Rhinoceros Auklet	Date
Langara Island		26*			May-Jun 1981
Frederick Island		54	65		May-Jun 1981
Hippa Island	82	78	83		May-Jun 1983
Helgesen Island		63			May 1986
Anthony Island			74	64	May-Jun 1985
Rankine Islands		66	62		May 1984
Bolkus Islands		83			May 1985
Skincuttle Island		57			May 1985
George Island		77	75		May 1985
Jeffrey Island			71		May 1985
East Copper Island		63	83		May 1985
Alder Island		65	80		Apr 1985
Ramsay Island		65	71		Apr-May 1984
House Island		45			May 1984
Lyell Island		52			Apr-May 1982
Reef Island		63			May-Jun 1985
Limestone Is.(E)		61			Apr-May 1983
(W)		20*			Apr-May 1983
Skedans Island	95		71		May 1983
Moore Islands				77	Jun 1988
Whitmore Island				77	Jun 1988
Byers Islands			85	94	Jun 1988
Storm Islands	90			77	Jul 1987
Reid Islands	91				2 Aug 1987
Tree Islets	90				Jul 1986
Pine Island				87**	Jul 1985, 1986
Buckle Group					
- Bright Island	95				3 Aug 1987
- Herbert Island	92				3 Aug 1987

APPENDIX I. (continued)

Colony	Species: Storm-Petrel	Ancient Murrelet	Cassin's Auklet	Rhinoceros Auklet	Date
Triangle Island				66**	Jul 1984, 1985
Sartine Island			91		Jul 1987
Beresford Island	81		90		Jul 1987
Gillam Island	98				Jul 1988
Solander Island	97				Jul 1988
Thomas Island	85				Jul 1988
Cleland Island	83				Jul 1988
Seabird Rocks	100				Jul 1988
Median	91	63	75	77	

* Rates for Ancient Murrelets from Langara Island and west Limestone Island were not included in the calculation of the median occupancy rate since these are thought to be disturbed and declining colonies. (Though this did not change the median rate.)

** Rates for Rhinoceros Auklets from Pine Island and Triangle Island are averaged over two years of data.

Data from this report, Rodway et al. 1983, Rodway et al. 1988, Rodway and Lemon 1990, in prep. a,b., Rodway et al. 1990a,b.

APPENDIX II. Permanent seabird monitoring plots established in the west coast Moresby Island region.

As part of the Permanent Seabird Monitoring Program for the British Columbia coast, Permanent Plots for Rhinoceros Auklets were established on Anthony Island in 1985. A detailed description of each plot and the number of burrows found within each plot is housed in the Permanent Seabird Monitoring Program file at the Canadian Wildlife Service office in Delta, B.C.

Eight 10x10 m plots were established on the island, 4 on the west side and 4 on the east side (Fig. WM280-1). To keep the plots as inconspicuous as possible, no marked bearing points were used to help locate the plots. Locations were mapped on a 1:10000 air photo, and distances and bearings were measured to identified landmarks on shore. All plots were marked with engraved aluminum tags nailed on a cut cedar post hammered into the ground at the lower left corner of the plot (when facing the interior of the island). The corners of all the plots were marked with flat aluminum stakes, 1 1/2" wide and 2' tall. The stakes were colour coded with red, yellow, green and blue florescent tape, and ordered in a counter clockwise direction around the plot, beginning, when facing the interior of the island, with red at the lower left corner.

APPENDIX III. Banding and Morphometrics

During the course of population surveys we took morphological measurements of a number of birds and eggs. All adults and chicks measured were found in burrows. Eggs were being incubated unless otherwise noted. On Anthony Island in 1985, two adult and eight Cassin's Auklet chicks were banded.

Appendix III-a. Measurements of Ancient Murrelet eggs made at colonies on the west coast of Moresby Island.

Date	Clutch number	Weight (g)	Length (mm)	Width (mm)	
Helgesen Island - 1986					
17 May	1-cold	44.0	56.0	38.0	
	1-cold	43.0	56.8	37.3	
17 May	2-cold	49.0	60.5	38.8	
	2-cold	49.0	58.5	39.6	
18 May	3-cold	42.0	55.8	37.1	
	3-cold	40.0	54.8	36.6	
19 May	4	46.0	58.3	37.9	
	4	44.0	57.1	37.4	
19 May	5	44.0	58.6	37.6	
	5	40.0	58.0	36.5	
20 May	6-cold	45.0	57.5	38.1	
20 May	7-cold	40.0	56.0	35.8	
26 May	8	39.0	55.7	37.0	
	8	38.0	56.7	36.1	
29 May	9-cold	50.0	63.6	38.2	
29 May	10	42.0	58.2	38.2	
	10	42.0	58.5	38.4	
29 May	11	43.0	61.5	37.2	
	11	44.0	62.0	38.0	
29 May	12	44.0	59.5	37.9	
	12	42.0	58.9	37.0	
29 May	13-cold	41.0	57.0	36.5	
Lihou Island - 1986					
10 May	1	49.0	62.0	38.6	with adult
	1	47.0	58.7	38.9	
10 May	2	44.5	58.9	37.3	with adult
	2	41.0	58.1	35.8	
10 May	3	49.0	62.4	38.0	with adult
	3	48.0	60.5	38.0	
10 May	4-cold	46.0	58.1	38.1	
	4-cold	44.0	60.3	37.0	

Appendix III-b. Measurements of Cassin's Auklet eggs made at colonies on the west coast of Moresby Island.

Date	Clutch number	Weight (g)	Length (mm)	Width (mm)
Helgesen Island - 1986				
26 May	1	34	46.0	34.6
Lihou Island - 1986				
10 May	1	29.5	48.4	34.7
Anthony Island - 1985				
27 May	1-cold	28.5	45.8	35.0
28 May	2	29.0	50.1	34.0
28 May	3	24.0	46.5	32.2
28 May	4	22.5	45.4	33.0
31 May	5	23.0	43.2	33.1
31 May	6-cold	27.5	47.7	33.4

Appendix III-c. Measurements of Cassin's Auklet chicks made at colonies on the west coast of Moresby Island.

Date	Weight (gm)	Tarsus (mm)	Culmen (mm)	Wing (mm)
Anthony Island - 1985				
25 May	112.0	24.2	13.9	57.5
25 May	40.0	27.9	10.7	20.0
25 May	87.0	22.4	12.6	29.0
25 May	88.0	23.7	18.3	35.5
25 May	93.0	22.8	14.2	41.0
26 May	43.0	21.5	12.2	21.0
27 May	139.0	26.3	19.0	83.0
27 May	112.0	23.9	14.5	61.0
27 May	101.0	23.0	13.9	39.0
28 May	126.0	24.4	14.1	59.0
28 May	85.0	22.2	13.3	29.0
28 May	78.0	23.6	13.9	31.0
29 May	134.0	26.7	15.9	59.0
29 May	40.0	19.8	11.7	21.0
29 May	93.0	23.2	14.3	39.0
29 May	70.0	22.3	12.6	27.0
30 May	75.0	23.4	14.4	34.0
31 May	24.5	17.2	10.4	16.0
31 May	133.0	26.1	14.9	68.0
31 May	164.0	27.2	15.8	93.0
31 May	108.0	24.1	13.7	53.0
31 May	94.0	23.9	13.9	50.0

Appendix III-d. Measurements of Cassin's Auklet and storm-petrel adults at Anthony Island in 1985.

Date	Species	Weight (gm)	Tarsus (mm)	Culmen (mm)	Wing (mm)
28 May	Fork-tailed Storm-Petrel	54	26.0	14.1	155
	Fork-tailed Storm-Petrel	55	27.0	15.3	158
28 May	Leach's Storm-Petrel	42	24.3	16.7	156
28 May	Cassin's Auklet	200	26.9	17.4	134
29 May	Cassin's Auklet	167	26.3	19.5	130

Appendix III-e. Measurements of Rhinoceros Auklet eggs made at colonies on the west coast of Moresby Island.

Date	Clutch number	Weight (g)	Length (mm)	Width (mm)
Helgesen Island - 1986				
22 May	1	80.0	67.1	47.7
22 May	2	87.0	71.7	47.5
22 May	3	74.0	67.6	45.5
29 May	4	70.0	67.7	44.9
Helgesen Island - 1987				
21 June	1	70.5	68.3	43.6
21 June	2	78.5	69.4	48.5
21 June	3	71.5	68.5	46.8
21 June	4	71.5	71.1	44.6
21 June	5	72.5	70.0	46.2
21 June	6	70.0	67.7	45.1
Lihou Island - 1986				
21 May	1	77.0	66.4	46.1
Anthony Island - 1985				
25 May	1	77.0	68.3	45.6
25 May	2	86.0	70.8	50.6
30 May	3	86.0	70.2	47.6
31 May	4	88.0	69.8	49.5
31 May	5	85.0	72.7	47.1
31 May	6	77.0	68.7	45.6
31 May	7	95.0	71.6	47.9
1 June	8	74.0	66.5	45.5
1 June	9	78.0	67.6	46.7
1 June	10	84.0	67.9	48.9
1 June	11	72.0	66.6	45.3

APPENDIX IV. Experimental Plot to Monitor Burrow Longevity on Saunders Island.

The recent abandonment of the colony on Saunders Island presented a valuable opportunity to monitor the length of time burrows remain recognizable after they are no longer in use. The length of time it takes for an unused burrow to disappear has important implications for population studies where burrow numbers are often the most reliable statistic obtained. To monitor the longevity of these abandoned burrows, we mapped, staked, photographed, and classified 33 burrows according to the amount of vegetation growing in the entrance. This plot was established on the mid-south side of the island (Figure WM020-1) in predominantly grassy habitat with frequent patches of moss. Burrows were selected in various micro-habitats such as under roots, grass tussocks, and into the open bank. As burrows appeared to have been abandoned the previous year, there was some vegetation beginning to grow in almost all entrances. To simulate burrows that had just been abandoned, we cleaned the entrances of 6 burrows so they appeared worn, without vegetation, similar to active burrows.

This plot was revisited in 1987 and 1988, and should be visited annually to properly follow burrow conditions. Burrows were still identifiable in 1988, but vegetation was obscuring entrances of burrows in grassy areas.

APPENDIX V. Birds and mammals sighted during seabird nesting surveys, 1985-1986.

The following table is a summary of bird and mammal sightings made while conducting inventories of nesting seabirds on the west coast of Moresby Island. Sightings are described in more detail in the individual island accounts under Associated species and Other sightings. Dates of sightings correspond to the survey dates listed in the island accounts. Most sightings have been recorded with more detailed information on sight record cards filed at the Royal British Columbia Museum.

Key to symbols used on table.

x: recorded
9: maximum sighted
i: immature
11i5: means 11 immature,5 adults
n: nests
2n14: means 2 nests, 14 birds
m: male
f: female

Abbreviations used for bird and mammal species follow Campbell and Harcombe 1985 (see Appendix VI).

Appendix V (cont'd.)

	COLO	SOSH	DCCO	PECO	GBHE	HOSL	HADU	COME	BAEA	PEFA	WATA	SPOT	WHIM	HEGU	GWGU
WM-020 Saunders I.				10i2					4n				8	5*	
WM-030 Helgesen I.						2			5i	1	1		2		
WM-040 Willie I.			3						3n						
WM-050 Carswell I.									2n						
WM-070 Instructor I.									2		1				
WM-080 Lihou Island									5n7i	1					
WM-090 Bone Point				1i1										3i1*	28i
WM-100 Luxmoore I.									1n1i						
WM-110 Rogers I.									1n						
WM-120 Cape Kuper									4n						
WM-130 Moresby Its.				1i6				1m1f	1n3i						
WM-270 Adam Rocks				3i12			1m								
WM-280 Anthony I.	2				1				11n5i	2m1f		1	2		
WM-290 Flatrock I.				64i2											
WM-300 Gordon Is.									1n	1m1f	1				
WM-310 St. James I.															
WM-320 Kerouard Is.		1000's							7i1	1m1f				1i	

*Herring/Thayer's Gull - identity uncertain.

(cont'd.)

	MAMU	BEKI	RUHU	RBSA	HAWO	NOFL	WEFL	EAKI	BBMA	MWCR	CORA	CBCH	WIWR	SWTH	HETB
WM-020 Saunders I.						x				x	x	x	x		
WM-030 Helgesen I.	3		x	x	x	1n	x			10	1n	x	x	x	x
WM-040 Willie I.										10					
WM-050 Carswell I.															
WM-070 Instructor I.	1		x	1n	1n					1n					
WM-080 Lihou Island			x				x			3n	1n		x	x	
WM-090 Bone Point															
WM-100 Luxmoore I.			x							3			x		
WM-110 Rogers I.					x					x					
WM-120 Cape Kuper				x		x				3n20	2		x		x
WM-130 Moresby Its.	1									1n4			x		
WM-270 Adam Rocks															
WM-280 Anthony I.	1	x	x		x		x	1	1	1n	1n	x	1n	x	x
WM-290 Flatrock I.															
WM-300 Gordon Is.			x							6	x		x		x
WM-310 St. James I.			x							x					
WM-320 Kerouard Is.			x							5	1				

Appendix V (cont'd.)

	VATH	OCWA	TOWA	WIWA	FOSP	SOSP	DEJU	RECR	PISI	EUJU	PHVT	LUCA	ODHE	TAHU	MAAM
WM-020 Saunders I.	1n	x	x								17	x	x		tracks
WM-030 Helgesen I.	x	x	x		x		x	x				x	x		
WM-040 Willie I.			x			x				7			x		
WM-050 Carswell I.															
WM-070 Instructor I.					x							x	x		
WM-080 Lihou Island		x	x								49		x		
WM-090 Bone Point															
WM-100 Luxmoore I.	x									7		x	x		
WM-110 Rogers I.			x									x			
WM-120 Cape Kuper	x		x			x					4	x		1	
WM-130 Moresby Its.		x			x	x				60		x	x		
WM-270 Adam Rocks						x			x		10	x			
WM-280 Anthony I.	x	x	x	x	3n	3n		x	x	50	12	x	x		
WM-290 Flatrock I.															
WM-300 Gordon Is.		x			x	x			x		2	x			
WM-310 St. James I.		x			x	x						x			
WM-320 Kerouard Is.					10's	10's				820		x	0		

APPENDIX VI. Index to species names and acronyms.

Birds:		
Common Loon	Gavia immer	COLO
Sooty Shearwater	Puffinus griseus	SOSH
Fork-tailed Storm-Petrel	Oceanodroma furcata	FTSP
Leach's Storm-Petrel	O. leucorhoa	LSPE
Double-crested Cormorant	Phalacrocorax auritus	DCCO
Pelagic Cormorant	P. pelagicus	PECO
Great Blue Heron	Ardea herodias	GBHE
Northern Shoveller	Anas clypeata	NOSL
Harlequin Duck	Histrionicus histrionicus	HADU
Common Merganser	Mergus merganser	COME
Bald Eagle	Haliaeetus leucocephalus	BAEA
Peregrine Falcon	Falco peregrinus	PEFA
Black Oystercatcher	Haematopus bachmani	BLOY
Wandering Tattler	Heteroscelus incanus	WATA
Spotted Sandpiper	Actitis macularia	SPOT
Whimbrel	Numenius phaeopus	WHIM
Herring Gull	Larus argentatus	HEGU
Thayer's Gull	L. thayeri	THGU
Glaucous-winged Gull	L. glaucescens	GWGU
Common Murre	Uria aalge	COMU
Pigeon Guillemot	Cepphus columba	PIGU
Marbled Murrelet	Brachyramphus marmoratus	MAMU
Ancient Murrelet	Synthliboramphus antiquus	ANMU
Cassin's Auklet	Ptychoramphus aleuticus	CAAU
Rhinoceros Auklet	Cerorhinca monocerata	RHAU
Tufted Puffin	Fratercula cirrhata	TUPU
Belted Kingfisher	Ceryle alcyon	BEKI
Rufous Hummingbird	Selasphorus rufus	RUHU
Red-breasted Sapsucker	Sphyrapicus ruber	RBSA
Hairy Woodpecker	Picoides villosus	HAWO
Northern Flicker	Colaptes auratus	NOFL
Western Flycatcher	Empidonax difficilis	WEFL
Eastern Kingbird	Tyrannus tyrannus	EAKI
Black-billed Magpie	Pica pica	BBMA
Northwestern Crow	Corvus caurinus	NWCR
Common Raven	C. corax	CORA
Chestnut-backed Chickadee	Parus rufescens	CBCH
Winter Wren	Troglodytes troglodytes	WIWR
Swainson's Thrush	Catharus ustulatus	SWTH
Hermit Thrush	C. guttatus	HETH
Varied Thrush	Ixoreus naevius	VATH
Orange-crowned Warbler	Vermivora celata	OCWA
Townsend's Warbler	Dendroica townsendi	TOWA
Wilson's Warbler	Wilsonia pusilla	WIWA
Fox Sparrow	Passerella iliaca	FOSP
Song Sparrow	Melospiza melodia	SOSP
Dark-eyed Junco	Junco hyemalis	DEJU
Red Crossbill	Loxia cruvirostra	RECR
Pine Siskin	Carduelis pinus	PISI
Mammals:		
Northern Sea Lion	Eumetopias jubatus	EUJU
Hair Seal	Phoca vitulina	PHVT
River Otter	Lutra canadensis	LUCA
Sitka Deer	Odocoileus lemionus	ODHE
Marten	Martes americana	MAAM
Raccoon	Procyon lotor	PRLO
Black Rat	Rattus rattus	RARA
Red Squirrel	Tamiasciurus hudsonicus	TAHU